Telephone Engineer

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The Call of Today Is for Specialists

"Learn to do one thing; and to do it well." Probably no better piece of advice could be given by parents to any boy or girl planning eventually to enter the world of business. This is true today as never before in the history of America, and the telephone industry is no exception. The Jack-of-all-trades is no longer considered a valuable employe. The call of today is for specialization.

The public requires efficient service whether it be in the store, the shop, the office, or the field. Speed plus accuracy is the demand of the hour, and the success of any business is determined largely by the amount of each which is given. The good blacksmith has been found incompetent as a salesman; the printer incompetent as an electrician; and the automobile mechanic incompetent as a telephone lineman. Even the blacksmith today must be technically trained if he is to succeed in this era of keen competition.

Heads of departments know how to get the quickest and best results, and they demand workers who will get these desired results for them, and in the desired manner. The day is past when the individual in search of work can apply for just any job. He must be schooled and practiced in the line of activity in which he assumes he can qualify, and must submit records or reliable references to prove his contention, or he will not meet with the favor of employers. The modern trend is toward shorter working hours and additional production, which can be accomplished only through increased efficiency. This is true in every branch of industrial, commercial, or professional endeavor.

Every man and woman who enters the telephone field must show efficiency and proficiency, if he is not to stand aside and give his place to others who have both the qualifications and the desire to help keep the system as nearly perfect as is possible with human brains and energy.

This does not mean that only college graduates can advance in the telephone business, although some training undoubtedly is an asset. But it does mean that the young man or woman who takes telephone employment, should start out with a determination to learn his job thoroughly for the sake of his individual future as well as that of the company. He should study his job, watching always for new and improved methods of carrying out his duties, whether they be at the switchboard, in the workshop, or on the line. Anyone can become a specialist if he goes at his job with sufficient energy and determination. And it is the specialist who wins advancement; an assured position; and the best pay the business affords.

The Rural Telephone Situation

Will the unemployed in the cities drift back to the farms? Will farming interests in the United States drift into ownership of large land corporations? Will rural telephone patronage shrink until only the large land owner can afford to pay the cost of service to a scanty patronage? Should rural telephone equipment be reconstructed into first-class condition or merely "kept going" by temporary expedients until we see what the future may develop in rural life eventualities?

Financiers who must furnish the money to rebuild dilapidated equipment, and farmers who need telephone service might do well to give serious consideration to present and possible future conditions of the rural telephone.

The matter is both an engineering and commercial problem. If present unfavorable farm conditions continue there is bound to be losses in rural telephone patronage to an extent that may put investments in such property in jeopardy unless engineering genius can devise ways and means of reducing equipment and operating cost to meet the subscriber loss in revenues. It may be that this can be done, but it will take some time to work it out. In the meantime, patronage may fall away to a serious extent, unless we safeguard it with at least temporary action.

Our opinion is that rural telephone patrons can be retained by providing them with efficient service.

A few equipment repairs and other improvements might often make it possible to furnish better talking facilities than many rural systems have made possible in recent years.

However, in connection with new additions and improvements, it is highly questionable whether it would be wise to attempt a rate increase, especially throughout the duration of the present slump in the farmer's business.

The towns and cities need the farmers within telephone call; the farmers need telephone connection with their neighbors and their markets; and the telephone owners need this business to meet unyielding upkeep costs.

In the present rural telephone emergency, it will be the level-headed telephone owners who are not afraid to provide a good quality of telephone service, who will stimulate the business between the city and the country, to his own ultimate profit.

The Intrinsic Meaning of Safety First

A leading factor in any business where the health and safety of employees is involved is the faithful observance of the expression which has come to be a national slogan, "Safety First."

To many employers, especially small telephone organizations, little or no attention is paid to this matter beyond the selfish protection by indemnity insurance, and some do not furnish even that for their employees. But, insurance or no insurance, the well-being and enthusiasm of employees demands as large a measure of safety, protection, and caution as it is possible to provide for them. Employers will find it a wise investment of time and money to make frequent inspections of all apparatus used by their employees, ascertaining its safety. They should also give frequent suggestions as to carefulness in taking no unnecessary risks both on the daily job and in walking or driving on the public highways.

The larger telephone companies have regular inspection periods for all equipment used in the activities of their business. They keep constantly before their employees the necessity of "safety first" in every piece of work which involves a risk. Trucks and other vehicles used in the business should not only be kept in safe condition but the drivers should be fully advised and admonished as to the law and the safety of themselves and of the other fellow. This will help insure public appreciation and favorable public relations and it will also add to the protection of the driver, of the machine he is driving, and of the public. He will give you more enthusiastic service if he feels that you are helping to protect him from injury.

Likewise, with regard to inside apparatus and employees, safety and healthy environment will add to efficiency and to your own protection against loss of time by illness or injury of employees. Ventilation and heating of working rooms, refreshing drinking water, rest periods whereby employees will not become depressingly fatigued, cheerful lighting, and cleanliness—all will contribute to the giving of high grade service that patrons appreciate. All this is included when we say "Safety First" and the observance of it will add to the quality of our service and the jingle of our cash register.

Conventions Bring New Life to Telephony

With the advent of Spring, renewed activities in all lines of endeavors always take the place of Winter's lapse in energy. Mankind generally joins nature in rejuvenating that which has been dormant during the Winter months.

Telephone people are particularly concerned about the progress of business, and the best means of improving service to the end that they hold present patrons and add new ones. The problem is complicated by the necessity of spending no more money than is absolutely necessary, and yet promoting upkeep in a way that will add popularity to telephone service.

How are we to inform ourselves on these important requisites to successful business? Can it be done by staying at home with eyes and ears closed to the newer and more convenient and economical methods of doing things? No, progress never gets in a rut and success never searches out inaction for its favors. If we succeed we must use our heads and our hands, and the more energetically and intelligently we do this, the larger will be the measure of our achievements.

No telephone man or woman can consistently say that ways and means of improvement in their business or vocation are closed to them. National, state, district and neighborhood telephone conventions and conferences make possible the opportunity for everybody in the industry to gain a knowledge of newer and more successful ways of doing things.

Convention schools of instruction are not beyond the comprehension of the telephone man or woman, nor beyond his means of application. In such conferences the tried and the practical always has its inning and we can take of the experience of others as a reasonably safe guide to better things for ourselves. Improvement is the surest guide to advancement in any avenue of life, and no telephone convention or conference has ever been held that did not afford new suggestions and ideas worth trying in our business.

Elementary Course in Telephone Practice

Here Is the First Installment of the Long Awaited Story of the Telephone Prepared by O. B. Fensholt as a Basic Study of the Telephone Field, Including an Explanation of the Relation Between the Telephone and Electricity, Upon Which Beginners May Build Future Knowledge

Introduction

The following text is designed to benefit the man who is new to the telephone field, as well as for the experienced telephone man who may not have a clear understanding of telephone instrument parts nor of circuit reasoning.

The writer has endeavored to make these articles as simple and clear as possible in order that any person interested in telephony may understand the subject matter. Realizing that the average technical books take for granted too much basic knowledge of the telephone, and do not sufficiently explain many of the details which seem simple to the technical writer yet an understanding of which are vital to advanced study, the writer has prepared this series of elementary telephone lessons from the point of view of an instructor explaining his subject to a student who has absolutely no previous knowledge of the telephone.

In fact the material presented in the ensuing articles is information which the writer himself attempted unsuccessfully to find when he was a beginner in the telephone field. Later he completed his university training and an additional course in telephone engineering. It is as the result of this training combined with many years of actual experience as a telephone man that he has compiled this material which should be of untold value to the beginner and serve to supplement previously gained knowledge of the "old timer."

The text has been divided into two sections, namely, Ohm's Law, and The Instrument Circuit.

Regardless of whether the student is an outside man or an inside man, this material will be of value to him, since the principle of all telephone problems is based on instrumental circuits, and the apparatus of the central office is simply a repetition of the principles of various instrument parts.

For example, if the student understands all the actions of ringers and receivers, he will then also understand the principle of the various relays in the central office. Also, if he thoroughly understands the induction coil of his telephone instrument, he will understand the principle of the induction coils, repeating coils, and retard coils of the central office.

Ohm's Law will be discussed before explaining anything of the telephone instrument, because it is necessary that the student understand the flow of electricity and its application to coils, in order that he may understand resistance to both series and parallel circuits.

To understand electrical problems as applied to the every day use of the telephone, it is not necessary to have a college education, but is essential to completely understand Ohm's Law. This will facilitate the working of problems with fractions and decimals.

Since electricity is fast, it is best to use words or terms that are also fast. That is, one word may be used to mean an entire sentence. It might be said that a foreign language, or short-hand, must be studied. The "foreign language" and "short-hand," however, are universal and understood by any one dealing with electricity. After this "language" has been mastered, these single words and marks which have a meaning requiring one or more sentences to adequately express, will be called "formulas."

The dictionary's definition of a formula is "a fixed rule." Therefore fixed rules will be used to find the answers to electrical problems.

In order to understand telephone operations, one must be able to visualize a current of electricity flowing through a conductor, and must be able to differentiate between positive and negative currents.

The writer has attempted to include all material regarded as essential to the understanding of Ohm's Law and the subscriber's instrument circuit. It has not been prepared in a technical fashion, but rather is semi-technical. Long, technical expressions and complicated formulas have been avoided until the student has been prepared for an understanding of them. Remembering always the premise: a man new to telephone work, the articles have been prepared step by step to lead the telephone beginner into a clear and comprehensive understanding of the industry with which he has cast his lot.

Electrical Pressure

We might start here by saying the question, "What is electricity?" and the answer would be, "No one knows." Rather let us ask, "What can we do with electricity?"

We might ask a large group of people, "What is iron?" and perhaps only one, if any, could answer. But everyone in that group would know something that could be done with iron. Therefore we are more interested in what we can do or make with iron than of what iron is made.

And so are we more interested in what can be done with electricity than as to what it is.

Electricity, insofar as we are concerned, consists of three things: First, Pressure, something which causes a current. Second, Current, something in motion, caused by a pressure. Third, Resistance, something that tends to hold back or regulate the current. We may then say that "Electricity" is just a word or short way of saying, "Electrical pressure, current and resistance." All three are essential for electricity to be of value. When we speak of electricity doing something, we mean that there was an electrical pressure, which caused an electrical current (something in motion) and this current went through or was regulated by a resistance.

We know that when a current of water is flowing in a pipe, it is caused by a pressure, either from water stored up some place, or from a pump.

Electrical pressure can be produced by several methods, such as by chemical action, magnetic induction, heat or thermo-couple method, or static electricity.

Chemical action means primary batteries, such as dry cells.

Magnetic induction is accomplished with generators, transformers, induction coils, etc.

The heat or thermo-couple method is the principle upon which radio vacuum tubes are based.

Static electricity is caused by friction and may be noticed in combing your hair, petting a cat, walking across a rug, rubbing together two pieces of silk, etc.

We will explain later how electricity is made by these processes, but at present we want to show you that electricity has a pressure and that it can be stored just the same as we can store water. With water this pressure would come from a pump, or from a reserve supply such as a tank or lake on some high level. In electricity the pressure also would come from a "pump," known as a "generator," or from a reserve supply similar to a "tank," called "batteries."

In water we talk about the pressure in "pounds per square inch," and if you lived near a pumping station, the pressure would be greater per square inch than if you lived further away.

Electricity is not measured in pounds per square inch, so we will have to manufacture a word for electrical pressure. This word we will call "volts."

"Volts," therefore, mean electrical pressure, or that which causes a current of electricity to flow, and is the same to electrical problems as "pounds per square inch" is to water problems.

We now have one word of our foreign language: "Volts": the pressure of electricity that causes an electrical current to flow.

Electrical Current

As telephone men, we are interested in electricity only when it is motion. At rest, electricity has no value to us. So let us think of electricity as something in motion.

If we wanted to see water in motion, or the current of water flowing through a hose, we could cut the hose and insert a glass tube between the two severed ends, and we could then see the water flowing through the glass tube.

We measure the quantity of water with a standard measure known as a gallon, which is a given quantity. Then if we wanted to know how much water was flowing in a pipe, it would be rated in quantity and time. It would be rated in gallons per second. We know how many gallons pass a given point in one second. You will note that we are not talking quantity, but rather quantity in motion, or current. Therefore, if we say 5 gallons, we are talking quantity, but if we say 5 gallons per second we are talking about current.

Now, unfortunately, we are unable to see an electrical current pass through a glass tube, so we will have to use another method of explanation.

We can not apply any of our five senses to electricity, and for that reason it is difficult to understand. That is we cannot see it, smell it, hear it, feel it nor taste it. What we do see, smell, hear, feel and taste is something which is *caused* by electricity. For example, you do not see electricity when you see a lightning flash; you see a light caused by electricity. You do not smell electricity, but a gas caused by electricity. You do not hear electricity where there are sparks or thunder, but rather something such as gas explosions or rushing of air currents caused by electricity. Neither do you taste electricity when you put your tongue across battery terminals. What you do taste is a salt or chemical action caused by electricity.

You will notice then that although we do not know what electricity is, we know the effects that can be caused to apply to our five senses.

To clearly understand electrical current, we will have to use our imagination and try to picture an electric current as consisting of a moving crowd of small people. In fact these people would be so small that they could not be seen with the naked eye.

Electricity will have to be measured in a quantity the same as water. When we say one gallon, one-half of a gallon or two gallons, etc., of water, we are actually picturing a certain amount or quantity of water. We will, therefore, have to have a standard measure or word for electrical quantity. Let us manufacture a word, and call it "coulombs" (pronounced koo-lums). Let each coulomb represent one of these imaginary people. Coulombs then would be a quantity of electricity or an amount of electricity. That is, it is the measure of quantity of electricity—*at rest.*

This word "coulomb" will be the second word of our foreign language, and it is a standard measure of *quantity* of electricity, the same as gallon is to water.

Previously we said we were only interested in electricity in motion, so we are not greatly interested in the term coulombs or quantity, but rather coulombs in motion or current. We will then consider "coulombs per second," the same as gallons per second, meaning the number of little people passing a given point in one second. If we say the electric current is 5 coulombs per second, we mean that 5 of these little imaginary people are passing by at the rate of 5 per second. We might state here that each one of these little people or coulombs are of equal strength, and if you had one-half a coulomb, you would have one with only half strength.

Before we can proceed it is absolutely necessary that you clearly understand, or can picture, a quantity of electricity and this quantity in motion, flowing past a given point in one second.

We said before that since electricity is fast we would have to manufacture terms or words that are also fast. Our first example is the word "electricity" itself, which means current, pressure and resistance. The first word coined for the "language of electricity" was "volts," the pressure which causes an electric current to flow. The second was "coulomb." Let us now make a single word that means "coulombs per second." The word we will call "ampere." This will be the third word of our foreign language, and:

"Ampere" means "coulombs per second."

If you hear the word ampere, then, it means the amount of electricity in motion, or the number of coulombs per second. Then 10 amperes would mean that 10 coulombs (little people) are flowing past a given point in one second.

We might now forget the word coulombs, as we will not use it in our formulas. We might, however, use the word as reference to these imaginary people.

Amperes (currents of electricity) can not be seen in a conductor or wire, which makes electrical problems more difficult to understand. A current gauge or meter, known as an ammeter, must be inserted in the circuit to indicate the amount of current flowing.

The greatest mistake that most people make is in confusing amperes and volts. Remember that "amperes" is the *quantity* of electricity in motion per second, and "volts" is the pressure which causes the amperes.

For convenience, let us make a chart, comparing our electrical terms with water:

Unit	*Electricity*	*Water*
Quantity	Coulomb	Gallon
Pressure	Volts	Lbs. per sq. in
Current	Amperes	Gals. per sec.

Because of the fact that you cannot see electricity in a conductor, practice "safety first," and never take hold of a wire that you know nothing about. It perhaps looks harmless, but might carry a lot of current (amperes) and be very dangerous.

(*To be continued in the May issue*)

CONVENTION SCHEDULE

Ohio Independent Telephone Association, Deshler-Wallick Hotel, Columbus, Ohio, April 15, 16 and 17.

United States Independent Telephone Association, Southern District, Sheraton Hotel, High Point, N. C., April 22, 23, and 24.

Indiana Telephone Association, Indianapolis, May 6 and 7, Claypool Hotel.

Arkansas Telephone Association, Arlington Hotel, Hot Springs, May 14 and 15.

Up-State Telephone Association, Rochester, N. Y., May 20, 21, Seneca Hotel.

Pennsylvania State Telephone & Traffic Association, Hotel Penn Harris, Harrisburg, May 26, 27 and 28.

Kansas Telephone Association, Abilene, June 2, 3, 4, The Sunflower Hotel.

WE'RE HELPLESS—HELP US.

TELEPHONE ENGINEER desires copies of March, 1930, issue. Send us your copy, if you can spare it, and secure extension of your subscription.

The number of holders of all classes of stock in all companies of the Associated Telephone Utilities system increased approximately 15 per cent during 1930 to a total of 16,000, according to the annual financial report. Of the total number of stockholders, 9,600 own securities of Associated Telephone Utilities Co. and the balance of subsidiary companies.

Carrier Currents Used in Composite Work

Process of Sending Telephonic and Telegraphic Communication Over the Same Wire Simultaneously Is Here Explained by F. J. Dommerque, Fellow A. I. E. E., in the Fifth of His Series of Articles, Including a Brief Explanation of the Problem of Telegraphy.

Introductory Remarks

If one considers that hundreds of thousands channel miles of carrier telegraph are in use in this country on both open wire and cable circuits, and also that it is possible to use one pair of wires for one carrier telephone channel and 24 carrier telegraph channels, or for two carrier telephone channels and 12 carrier telegraph channels, or for three carrier telephone channels and 8 carrier telegraph channels, or finally one pair of wires for 36 carrier telegraph channels, the importance of carrier currents for telegraph service is fully evidenced.

It is a well known fact that space on telephone lines, principally on toll and long distance lines is leased to news agencies, stock brokers, etc., for telegraphing. It may be not so well known that carrier channels are used for telegraphic communication between toll boards of different cities. In the latter case as well as in all cases where space is leased, carrier channels are of great economical value.

Our interest centers in the composite work, that is, in using telephone lines for sending simultaneously telephone and telegraph messages over the same pair of wires.

We have fully illustrated the various phases of application of carrier currents to telephone transmission. In order to understand the similar application to telegraph transmission, it will be opportune to introduce the subject by a brief explanation of the problem in telegraphy.

The circumstance that with decreasing number of telephone carrier channels on a line the number of available telegraph channels increases in a much faster proportion, indicates that there can be accommodated more telegraph carrier channels in a given frequency range than telephone channels. The reason for this is that telegraph currents are of a lower frequency than telephone currents; consequently the side bands belonging to the different telegraph signals become narrower and thus can be crowded together more.

In ordinary telegraphy a series of voltages is applied to the line by closing and opening the sending circuits for short or long intervals in accordance with a signal code. In carrier telegraphy a relay is connected in the sending circuit, which permits corresponding high frequency signals to pass over the line. Fig. 1 shows such an arrangement. The upper part or curve is the representation of the signal "f" in the Continental Code, when sent out by the ordinary method of telegraphing; the lower curve expresses the corresponding high frequency spurts for the letter "f."

These spurts appear to be the only frequency transmitted; but it must be taken in consideration that it takes time, if ever so little, for the current to build up, and therefore the individual spurts will not attain their full height at the instant the carrier current supply is put on, but will be more or less rounded off. What is said for the building up process holds equally true for the decay of the current; thus it may be possible, that the signals are obliterated entirely, it all depends on the speed of signaling.

We have here a modulation effect, whereby it becomes necessary to transmit a certain band of high frequencies in a

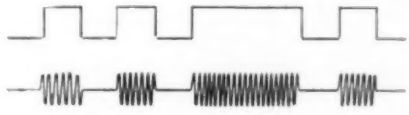


Fig. 1—Telegraph curves

similar manner to the band of frequencies in carrier telephony modulation. The current wave in the telegraph case may be thought of as a series of superposition of an infinite number of component oscillations of sine wave form having a range of frequencies from zero to infinity. The more of these oscillations become effective in the receiving apparatus, the better the transmission. The necessary band of frequencies to give satisfactory transmission is determined by the speed of signaling, which again depends on line constants, apparatus, etc., but it may be set down that if the components, whose frequencies are a few times the fundamental interruption frequency, are preserved an acceptable transmission will be secured. This is attained by limiting the band to about 200 cycles per second. In transmitting such a band the non-essential components are suppressed by selective circuits or filters, which prevent interference with other channels.

Assignment of Frequencies

It has become customary to assign the frequencies from zero to 200 to direct current telegraphy. The frequencies from 200 to, say, 3,000 form the frequency band of ordinary telephony. The frequencies from 3,000 to 10,000 serve for carrier telegraphy and the frequencies above 10,000 for carrier telephony. In order to secure duplex operation of telegraph carrier lines, it has been chosen to use different carrier frequencies for the two directions of operating. With ten duplex carrier telegraph channels on one pair of wires an arrangement of frequencies has been found suitable by which the frequencies from 3,300 to 6,000 cycles form the frequency range for operation in one direction and the frequencies from somewhat above 6,000 to 10,000 the frequency range for operation in the other direction. Of course there are other arrangements possible, but the rule is to group the carrier telegraph frequencies so that the channels operating in one direction employ frequencies below a certain value and the channels operating in the opposite direction frequencies above this value.

Description of Fundamental Circuit Arrangement

In Fig. 2 is shown a terminal for two telegraph carrier channels in addition to a regular telephone circuit, also a composite set in conjunction with an ordinary telegraph circuit. Each one of the carrier channels for telegraphy is composed of a sending and receiving circuit. Both channels, of course, are alike. Taking the sending circuit first. At the sending station a key is shown in series with a relay in the low-frequency line. By pressing the key K the relay R operates and short circuits the oscillator O. This

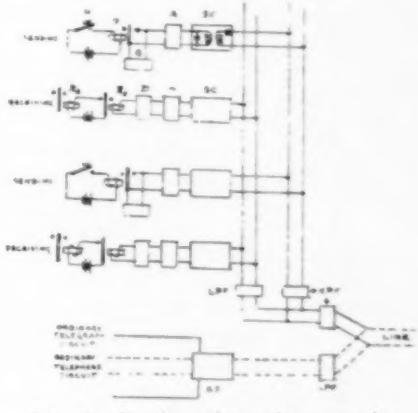


Fig. 2—Carrier telegraph composite circuit

oscillator may be of the tube or machine type; it does not require further description as it has been fully discussed in previous papers.

The starting and stopping of the car-

rier current by means of the key in accordance with the telegraph code signals is the function which corresponds to the modulation in carrier telephony and may be considered as a telegraph carrier modulation.

The short circuiting of the oscillator takes place during the spacing intervals and permits spurts of carrier-frequency current to pass through an amplifier A of the kind we have described at an earlier occasion, into a selecting circuit, SC, which in reality is a filter arranged somewhat different from the ordinary kind described in a previous paper, but provided with inductance coils and condensers suitable for the separation of the various frequencies. From the selecting circuit SC the current proceeds through a high-pass filter HPF to the line. As may be observed from Fig. 2 the resonant circuits are loosely coupled, which is done to preserve the advantages of band filters for the narrow transmission bands at high frequencies. Where the carrier frequency is of the order of several thousand cycles, the percentage difference in frequency between the extreme edges of the side band is so small as to make it difficult to design circuits to suppress one of the side bands. For this reason the frequency range assigned to a carrier telegraph channel has been made twice as large as the one of the essential frequency range of the direct-current telegraph channel.

At the receiving end of the carrier channel we find first the receiving selective circuit of the same description as at the sending end. The current then passes through an amplifier A to the detector D. The grid of the detector tube is made sufficiently negative to prevent the flow of current in the plate circuit when no high-frequency current comes from the amplifier, but when a high frequency alternating potential is applied to the grid by the spurts of the carrier frequency current a high-frequency current is made to flow in the plate circuit which operates the relay R_1, thus the detector acts as a rectifier. The contacts of this relay control the relay R_2 in the telegraph circuit.

The sending relay R and the receiving relay R_1 if they are to be used for duplex operation, must be polarized; the relay R_2 in the direct current telegraph apparatus circuit can be a local relay or a sounder.

Telegraphing Over Repeatered Telephone Lines.

It may be said in general that carrier telegraph messages can be sent over long lines with intermediate telephone repeaters by using the telephone repeater sets. At each repeater station only one such set is required for all the carrier currents to be transmitted after they are amplified.

This rule pertains particularly to open-wire lines of the two-wire type. For the so-called four-wire type repeatered circuits, where cable is used, an improved method of sending telegraph messages has been devised by the Bell Telephone Laboratories and installed by the A. T. & T. Co. some years ago between New York and Pittsburgh. This method has been termed a voice-frequency carrier telegraph system. In the New York-Pittsburgh line ten telegraph channels are accommodated by one four-wire telephone circuit. The number of telegraph channels that may be derived from one four-wire telephone circuit is, however, not limited to ten. It all depends on the character of the two metallic circuits which constitute the four-wire cable circuit. As the cables are loaded with inductance coils, the amount of inductance plays a role in the range of frequencies that can be transmitted. The inductance inserted in the New York-Pittsburgh line

Fig. 3—Voice-frequency carrier telegraph on four-wire telephone circuit

would not permit of a greater number than ten telegraph circuits on one four-wire circuit; if the inductance could be reduced, it may be possible to use fifteen or even more telegraph channels on one four-wire telephone circuit; the length of the circuit enters the problem to some extent also.

This voice-frequency carrier telegraph system is not materially different from the carrier-frequency telegraph system we just described for transmission over a two-wire circuit. The principal difference is, of course, that it is used on a four-wire cable circuit instead of a two-wire open-wire circuit. Sending and receiving relays are polarized. The oscillator serving for generation of the carrier currents for the telegraph channels is of the machine type. It is a small multi-frequency generator of the inductor-alternator type and generates ten different frequencies, which form the odd multiples of a basic frequency of 85 cycles per second, starting with the fifth multiple of 85, namely, 425 cycles. This would give a frequency of 1,955 cycles as the highest frequency used with a spacing of 170-cycle range between two frequencies following each other; that is, each channel would have one frequency range of 85 cycles below its own frequency, and a range of the same width above its own frequency.

The amplifiers for sending and receiving are placed between the points where all the telegraph channels have come together, and the line; that is, the amplifier for all the sending circuits is placed where the combined sending channels enter the one of the two-wire circuits forming the four-wire cable circuit, and the amplifier for all the receiving circuits at the point where the combined receiving circuits are connected to the other two-wire circuit.

Instead of the selective circuits used in Fig. 2 the voice-frequency carrier telegraph system is provided with fixed band pass filters to discriminate against the several carrier frequencies. These two filters are not alike. The sending filter is designed for transmission of a wide range of frequencies adjacent to the carrier frequency, which improves the quality of transmission and reduces interference from outside sources. The receiving filter's principal duty is to reduce all interfering currents to a minimum and protect the receiving circuits from distortion in the repeater tubes.

Both filters, sending and receiving, round off the modulated square telegraph wave; that is, they weed out the undesired components of the signal.

A further difference between the voice-frequency and the carrier frequency telegraph system is that the voice-frequency system uses the same frequencies for transmission in both directions instead of different frequencies each way. In Fig. 3 is given an idea of the arrangement of the ten telegraph channels on one four-wire circuit.

Two-Wire or Metallic Solar-Duplex Telegraph System

This system has been especially designed by the Bell Telephone Laboratories for composite work. It is a low-current system; that is, its operating current is of the same order of magnitude as the current of the telephone circuit on which the telegraph is superimposed. It may be used on two-wire and four-wire repeater circuits for cables. The metallic type was chosen for the telegraph to minimize any interference from the superposed telegraph, which would be excessive, if the ground-return telegraph were used. There are two batteries provided in this system for single commutation, and one for double commutation, the voltage being 34 volts. The telegraph current in the cable circuit with the batteries at the two ends aiding, is from 3 to 15 milliamperes according to the line resistance. The line is provided with telegraph repeaters, through-repeaters for repetition between two metallic cable circuits, and terminal repeaters at the end of a metallic telegraph circuit. The maximum distance between two consecutive repeaters is about 120 miles on No. 19 gage cable, composited pairs, or 160 miles on No. 16 gage cable. For non-composited cables the corresponding dis-

(*Continued on page* 31.)

Convention Speakers Urge Business Methods

Wisconsin Telephone Association Holds Annual Meeting at Madison, March 17, 18 and 19. President Walter Gallon Advocates Sound Economical Operation of Telephone Companies; Application of Ordinary Sales Methods to Marketing of Telephone Service Suggested by Jay G. Mitchell; Secretary W. L. Smith Expresses Disapproval of Wisconsin Legislative Activities

Intention to fight bills now before the Wisconsin legislature was indicated vehemently by delegates attending the annual convention of the Wisconsin Telephone Association held at the Hotel Loraine, Madison, March 17, 18 and 19.

Secretary W. L. Smith, manager of the Badger State Telephone and Telegraph company of Neillsville, led the expression of disapproval as secretary of the association. He produced a handful of assembly bills at one of the meetings which had been introduced at the legislature the previous day and printed overnight. Among them were some five bills which affected telephone companies.

One of these, No. 595-A, fixes telephone rates in first class cities. If this principle is adopted, Secretary Smith declared, it will affect all telephone companies in the state.

Another bill places Wisconsin telephone companies on the same basis of ad valorem taxation as the power and light utilities.

"It is rather an anomaly," said Secretary Smith, "that the legislature should try to place telephone companies on an ad valorem rate which is used in taxing power and light utilities, while at the same time they are attempting to change the method of taxation of power and light to local rates.

"The danger to the telephone interests is that in two years, they may also attempt to place the telephone companies on a local and local district basis," he said.

One independent operator declared that the system of taxation would be particularly hard on the small operator.

"It looks as if they were going to be good teachers to learn us how to keep books fictitiously," another contributed.

Another declared that the new system of ad valorem taxation would mean that rates must be raised.

President Gallon's Address

The opening general session of the convention included the annual address by President Walter Gallon of Antigo.

"The telephone industry," he said, "seems to be settling down, now that the hideous merger craze has passed. The great struggle ahead of us now is sound, economical operation, and in that operation the spirit of cooperation between companies should, I believe, be the outstanding feature of our endeavor. Contractile alliances should not be made for the gain of one at the expense of another.

"It is natural to assume in an effort to bring about this cooperative thought that there will be marked differences in opinions. But I see no reason why these differences cannot be ironed out and cleaned up on an amiable basis suitable to all. The spirit of reciprocation between the various organizations, both large and small, should be our paramount endeavor.

"An important phase that has cropped up in the industry in the last four years is the unscrambling of many of these organizations organized by financial genii without a thought of sound operation. Many of these plants are isolated and join successful operating companies. It is assumed the companies that should get these isolated units are the ones that are immediately adjacent. This, you will readily see, will help in sound management and operation.

"Unfortunately, the prices of these organization are such that a carefully managed organization cannot buy them; and here again is where the suggested department of economics should come into the picture."

Marketing Telephone Service

"An Old Problem in New Clothes" formed the subject of an address by Jay G. Mitchell, general commercial superintendent, Commonwealth Telephone company, Madison. Mr. Mitchell discussed the matter of income, rates and the application of ordinary sales methods to the marketing of telephone service.

He said, in part:

"Under conditions when rate adjustments seem to be inadvisable, or at least difficult, there is a possibiilty of increasing revenues by the application of the one method which has been used by every other business since business was begun. This method involves the concept of applying ordinary sales methods to the marketing of telephone service.

"It is in furtherance of this general idea that the group of properties with which I have the privilege of being identified, has established as a distinct department of the general commercial superintendent's staff, a sales engineering department.

"This department is charged with the sales of service to potential subscribers, the sales of aditional usage of the toll service; the sales of collateral service, such as press service, telegraph service, short period exclusive talking service, telephone dispatching systems for power companies, private telephone service, and other kinds of collateral service which the telephone industry is mechanically and technically well equipped to render.

"The application of simple sales methods produces the most astonishing results. It is my thought that possibly present conditions, about which everybody talks and in which some of us actually believe, might be materially improved insofar as the operating telephone industry is concerned, if the industry should adopt and place in effect ordinary conventional sales methods to expedite and increase the sale of its products."

Continuing along much the same lines as that followed by Mr. Mitchell, Mrs. Dorothy A. Barber, traffic superintendent, Commonwealth Telephone company, Madison, discussed "Some Traffic Suggestions to Managers."

Stating that people of today are thinking and talking in terms of service, Mrs. Barber expressed the opinion that managers and chief operators in many instances had over-estimated the importance of equipment and under-estimated the human element. She declared that managers should be familiar with traffic methods and records to know what kind of a job the traffic department is doing.

"Economics of the Small Rural Exchange" was the subject of a talk by R. H. Burfeind, sales engineer, Automatic Electric, Inc., Chicago. Mr. Burfeind outlined a plan for grouping small exchanges together for automatic operation. He stated that the plan was first adopted in Wisconsin 15 years ago, and is still in successful operation.

MacKinnon Presides at Session

Increasing revenues through the sale of more telephone service was the theme of one session presided over by F. B. MacKinnon, president of the United States Independent Telephone Association. In speaking on "Maintaining the Prestige of the Telephone Company."

Walter Gallon of Antigo was re-elected president by the directors at a meeting held after the close of the convention; Herman Hoerl of Marshfield was chosen vice-president, and W. L. Smith of Madison, secretary-treasurer.

Telephone Activities Abroad

Dispatches from Foreign Countries Keep United States Telephone Men Informed Concerning Telephony of the World.

New Telephone Line Connects Rome and Berlin

As the result of the completion of a new underground cable between Milan and Rome, telephone communication entirely by underground cable is now possible between Rome and Berlin. The line comprises no fewer than 28 amplifying stations.

Thirty-five Circuits Between England and France

In order to meet the continued growth of traffic between Britain and France, additional circuits to Paris and Marseilles have been brought into service, making the total 35. All are operated from the London trunk exchange. Thirty-one terminate in Paris, and one each in Calais, Boulogne, Lille and Marseilles.

Italian Telephone Subscription Doubles

During the five years which have elapsed since the Italian government turned the management of telephone service over to private enterprise in 1925, the number of subscribers has more than doubled.

During the year 1928-29, 178 districts which previously could not be reached by telephone have been brought within the present network. But although all points of the peninsula can be reached by telephone, there are no less than 2,647 communes out of a total of 7,309 still unprovided with any sort of telephonic means of communication.

Probable Telephone Service for U. S. and Newfoundland

Toward the end of 1931 a telephone service may be established between the United States and St. John's, Newfoundland, according to Consul General Edward A. Dow, of St. John's. The Avalon Telephone company of St. John's, which operates the sole telephone service in Newfoundland, may join the American concern in initiating such international communication.

Manchurian Communication Developments During 1930

During the past year all telephone communications under Chinese administration were placed under control of the North Eastern Committee on Communications at Mukden.

The committee has plans for adding approximately 3,000 new telephones per annum. The Mukden Telephone company added 3,500 automatic telephones during 1930. Under Chinese control there are now approximately 350 telephone exchanges, of which 179, with a total of 8,400 subscribers and 25,000 miles of lines, are located in Liaoning province.

The combined total of Heilungkiang and Kirin provinces is slightly less. Some improvements were made during the year in long distance telephone operation. Under the control of the South Manchuria Railway company there is an additional number of approximately 15,000 telephones to which numerous small additions were made during the year.

Long Distance Lines Opened in Colombia

The new long distance telephone line between the cities of Girardot and Armenia connecting the departments of Cundinamerca and Caldas, was put into operation recently, followed shortly by the opening of service between Bogota and Buenaventua, thus affording incalculable benefits to the two cities and the commercial districts served. The long distance lines will connect with the service already existing in Bogota and Cali when completed, so that persons living in those two cities can communicate from their homes or offices.

Telephone Tests Between Greece and Yugoslavia

Telephone tests between Belgrade, Yugoslavia, and Saloniki, Greece, have been carried out with excellent results. A regular service will shortly be inaugurated between Athens and Belgrade, according to the *Electrical Review*.

Argentine Telephone Service Extended in 1930

The *Buenos Aires Herald* of January 10, on the subject of the extension of telephones during the year 1930, refers to the remarkable work of the Union Telephone company. This company carried telephone communications to 47 towns in the republic previously isolated and extended their service to 24 foreign countries on three continents. Foreign expansion dates from October, 1929, when communications with Chile and Uruguay were established. Locally, automatic equipment has been increased to accommodate 26,000 more subscribers. In Rosario 2,100 lines were added, in Cordoba, 1,000, and in Santa Fe, 300. Conductor meters of underground cable laid in all parts of the republic totaled 175,800,000; 14,800,000 conductor meters of aerial cable were laid and 4,770 meters and other wire were added to the local telephone system. The number of telephones connected to the Union Telefonica system was increased by 20,220, making a total of 236,213.—(American Ambassador Robert Woods Bliss, Buenos Aires, Argentina, January 14, 1931.)

Half of All Chilean Telephones Are Automatic

The principal cities of central Chile, namely, Santiago, Valparaiso and Vina del Mar, are equipped with automatic switchboards, according to a bulletin from Commercial Attache Ralph H. Ackerman, Santiago. Approximately 55 per cent of all the telephone service in Chile is automatic; 13 per cent of the total equipment is of the central battery manual type while the remaining 32 per cent is magneto manual battery. Automatic service is under the ownership of the Chile Telephone company, which concern intends to install this type of equipment throughout its entire service.

Annual Report of Manitoba System Shows Surplus

A net surplus of $185,303 for the fiscal year ended November 30, 1930, is shown in the annual report of the Manitoba Telephone system, submitted by J. E. Lowry, commissioner, to the Manitoba Legislature. Gross revenue for the year amounted to $3,887,917, as compared with $3,873,386 for the previous year. Plant value increased by $818,888, which was responsible for an increase of $82,437 in fixed costs, interest and depreciation, while operation and maintenance costs increased by $27,990.

Number of telephones throughout the system was 75,415, against 76,042 for 1929, a net reduction of 627. The loss would have been much greater, the report stated, had not every means been used to afford subscribers, especially those on rural circuits, facilities for extending periods over which payments could be made. Arrangements were also made where an appreciable number were carried on payment of a small amount until such time as balance owing could be paid from the proceeds of unsold crops or other products. The commission for some time has been giving careful consideration to the question of a wider and, consequently, cheaper service in a number of the rural exchange areas, the report said. In some of these areas the number of subscribers was limited, and this, together with the fact that rural service is party line service, where as many as ten may be connected to one line, had impelled the study for a still further improvement to this branch.

Appropriation for storm damage during the year amounted to $102,500, although this figure was $35,000 short of the actual expense through storms, which exacted a heavy toll, particularly in the early winter of the year, when the plant was damaged to the extent of approximately $80,000.

Telephone Men Attend Utilities Convention

Executives and Employees of Telephone Companies Take Active Part in State Utilities Association Meeting March 10 and 11 in Oklahoma City; Houck McHenry, Vice-President, United States Independent Telephone Association Addressed General Session and Telephone Division

Telephone executives and employes, and manufacturers and electrical and telephone equipment and supplies comprised a large portion of the 700 persons who participated in the thirteenth annual convention of the Oklahoma Utilities Association at the Huckins Hotel, Oklahoma City, March 10 and 11, 1931.

Although the convention was cut from three days, as in former years, to two days, and entertainment features were eliminated in order to meet present economic conditions, it was considered one of the most successful in the history of the association from the standpoint of subjects presented and interest shown in the general and divisional sessions. The division programs were declared by many who attended the convention to be the strongest and most interesting in the history of the association.

A number of manufacturers' exhibits were held on the mezzanine floor of the hotel.

The national situation in relation to the telephone industry was discussed in the opeing general session by Houck McHenry, Jefferson City, Mo., vice-president of the United States Independent Telephone Association.

"We are in business today for two primary purposes," he said. "First, to serve our patrons; second, to receive a fair and just remuneration for that service. Service is our keynote." Mr. McHenry said that twenty years ago he was the owner and operator of a transfer and drayage company, and for the same length of time owner and manager of a local telephone company. "Those companies," he said, "enjoyed a practical monopoly; both paid licenses and taxes and used the same streets and alleys. Patrons of the transfer company seemingly did not care if that company made a billion dollars a year, but if the telephone company got within whistling distance of a 6 per cent dividend, they were a lot of robbers and something ought to be done about it."

The largest crowd assembled during the convention was attracted by the demmonstration and lecture presented by Sergius P. Grace, assistant vice-president, Bell Telephone Laboratories, New York, at the Shrine Auditorium. This feature was arranged and sponsored by the Southwestern Bell Telephone company through cooperation of the American Telephone & Telegraph company and Bell Telephone Laboratories. On account of the heavy demand for seats in the Auditorium it was necessary to issue admission tickets. All members of the convention and many others were presented tickets by the Southwestern Bell Telephone company and the Auditorium was crowded to capacity. Many marvelous developments in the science of communication were demonstrated by Mr. Grace, who in addition to being a high executive of the Bell Telephone Laboratories, is also a distinguished engineer in that organization. Among marvels of science demonstrated on the stage were: The artificial larynx, which enables many speechless people to talk by forming words with the mouth; a telephone dialing system, which speaks the numbers dialed by the subscriber to the operator in a manual telephone exchange; development of a flame which transmits words and music; amplification of the sound of movements of the human heart, muscles and blood, making them audible to audiences large or small, and scrambling of speech over telephone lines so as to produce a strange jargon, which can be reconverted into the original expression.

The telephone division was favored with the presence of two representatives of the United States Independent Telephone Association, Houck McHenry, vice-president of that association, president of the Missouri Telephone association, and president of the Capitol Telephone company of Jefferson City, Mo., and Miss Anne Barnes, Des Moines, Iowa, traveling chief operator, Iowa Independent Telephone association. These representatives played a prominent part in the telephone division sessions.

Mr. McHenry delivered an address upon "Maintaining the Prestige of the Telephone Company" at the telephone division meeting. Miss Barnes conducted the commercial and traffic conference, which was featured by an address by Miss Barnes and addresses by Miss E. Pauline Roach, Garber, revenue accountant, Western Telephone Corporation; Mrs. Callie Lee, Stroud, cashier and chief operator, Oklahoma Telephone company; R. J. Benzel, Oklahoma City, general manager, Southwestern Bell Telephone company. The commercial and traffic conference continued throughout the entire second day of the convention.

Reports of E. F. McKay, manager, and W. R. Emerson, treasurer of the association, were presented to the convention.

During the afternoon of March 11, the business session was held, which confirmed selection of the followig officers of the association, which had previously been made by the various divisions and the executive board. The officers are:

President, S. I. McElhoes, Oklahoma City, vice-president, Southwestern Light & Power company; first vice-president, R. J. Benzel, Oklahoma City, general manager, Southwestern Bell Telephone company; second vice-president, H. L. Montgomery, Bartlesville, manager, Cities Service Gas company; treasurer, W. R. Emerson, Oklahoma City, secretary-treasurer, Oklahoma Gas & Electric company; and Manager E. F. McKay of Oklahoma City. The latter two were re-elected.

C. G. Cardner of the Sentinel Telephone company was chosen chairman of the telephone division. Other telephone division officers were elected as follows: Board members, R. J. Benzel, Oklahoma City, and W. O. Mills, Skiatook, Standard Telephone and Telegraph company; division secretary, A. G. Davidson, Frederick, district manager, Southwest Telephone company; division treasurer, M. A. Sanders, Oklahoma City, connecting company agent, Southwestern Bell Telephone company.

Among manufacturers and suppliers who had exhibits at the convention were:

The Kellogg Switchboard & Supply company, Chicago; Automatic Electric company and American Electric company, Inc., both of Chicago; Stromberg-Carlson Telephone Manufacturing company, Kansas City, Mo.; General Electric company and General Electric Supply Corporation, both of Oklahoma City; Bond Electric Corporation, Chicago; Peerless Manufacturing company, Louisville, Ky.; Automatic Washer company,

The exhibits were among the most interesting features of the convention and Newton, Iowa; and Coffing Hoist company, Danville, Ill.
contained many modern developments in machinery, equipment and supplies utilized in connection with electric, gas, telephone and electric railway service.

The Scotia Telephone company has purchased a lot near the center of the town in Union, Mo., where the company plans to erect a new telephone exchange building in the near future. At that time the plant will be entirely modernized, including the substitution of a common battery system for the present magneto system.

Details of Installing the Subscriber's Set

Ray Blain Gives Minute Directions to Follow in the Proper Placing of the Telephone Instrument and the Running of the House Wire Which Connects It to the Protector; Says Proper Installations Will Materially Reduce Subsequent Trouble Reports.

After the drop wire has been run and the protector installed with a suitable ground connection, there still remains that all-important part of the substation installation, the proper placing of the instrument and the running of the house wire which connects it to the protector.

Selection of House Wire

The most commonly used house wire is the No. 19 B. & S. olive colored, generally referred to as inside wire. Twisted pair is used for the main line and triple for party lines. The twisted pair wire is generally provided with red and green tracers and the triple with red, green and yellow tracers. In some cases white inside wire is used when it matches the trip of the rooms where it is to be placed better than the olive colored wire, but due to the difficulty of keeping the white wire clean during the process of installation, it is not recommended for general use. When the house wire is to be run through damp basements or exposed to the weather, No. 18 B. & S. bridle wire is recommended. This type of wire can be obtained in either twisted pair or triple.

There has lately come into use a parallel inside wire which seems due to become quite popular in that it is much neater and takes up less space than does twisted pair. There is also a new type twisted pair wire with one outer covering over both wires which takes up much less room than does the regular twisted pair inside wire. We have made use of the latter type in crowded conduits in buildings with absolute success.

Installation of House Wire

The run from the protector to the telephone should be as short and direct as possible with necessary regard for appearances. If the wire is to be concealed in the walls, which is an accepted practice with most companies today, the holes should be bored where they will be the least noticeable. In most modern buildings conduit is placed so that telephone wiring can be taken care of in the same manner as the electric wiring. This makes the work of the installer comparatively simple. In older buildings where this conduit is not provided wire should be run along picture moulding, around door and window frames or along the top of the baseboard. Chair rails are to be avoided where possible but if they must be used the best practice is to tack wire on the under side. Wire should always be tacked as close to the plaster as possible on all wood moulding. To fasten wire to wood, ½-inch, and to plaster, ⅞-inch milonite nails are generally used. A small staple is generally used to fasten the new parallel inside wire to moulding. A small split knob has lately appeared on the market which makes an ideal means of attaching house wire in damp locations so that good insulation will be maintained.

In running wire through basements the most direct right angle route is generally followed. In laying out a basement wire run consideration should always be given to the placing of it where it is the least liable to mechanical injury. Avoid spanning open spaces between beams or studding and any location where the wire is likely to be covered with stored objects such as boxes. Never attach house wire to pipes of any kind as they are liable to collect moisture and cause trouble. Telephone wiring should clear all lighting circuits by at least two inches. Extreme care should always be taken to run wire so that it will not interfere with the operation of sliding doors or windows. If house wire must pass over or under lighting circuits it is a good practice to make the crossing through a porcelain tube which can be held in place by taping at both ends to the wire.

Wiring Through Walls and Floor

When passing wire through a partition wall of any kind of material it is always a good practice to cover the part of it which will be concealed with two layers of friction tape. Flexible loom, or woven conduit, as it is sometimes called, can be used instead of tape for this purpose if desired. A ⅜-inch hole should be drilled for a twisted pair wire, ½-inch for triple house wire, if the tape covering is to be used, and ⅝-inch hole for ¼-inch loom.

When running wire through floors it is, of course, always best to take it into the partition, but when this is not possible then it should be properly protected. One good plan is to place a short piece of iron conduit to carry the wire through the floor, but if this arrangement is not desirable, tape first with rubber and then friction tape. As water is generally used to clean floors, this covering should always be waterproof in addition to providing mechanical protection. Holes through floors should always be located either at desk legs or as close to baseboards as possible.

Installation of Subscriber's Sets

Whenever possible the telephone should be located in accordance with the wishes of the subscriber. If the subscriber has ideas which are not practical, the installer should explain why such an installation would not give service, and try to hit on a plan that will be both serviceable and acceptable to the subscriber. Install the instrument in a location so that the bell can be heard in every part of the house if possible. Avoid installing the bell box in closets, cellar-stairs or similar locations for the purpose of concealing it. Never locate bell boxes on damp walls or near a window which may be left open and expose the instrument, especially the cords, to damage from moisture. Locations which subject the set to vibration should always be avoided. Try to locate the set so that it will not come in contact with metallic objects such as radiators, sinks or light fixtures.

If a desk telephone is being installed in a residence insist that a suitable table or desk be provided to place the stand on when not in use. Some of the new houses being built have a telephone cabinet built in one of the partition walls which is a very neat and convenient arrangement.

Wall sets will ordinarily be installed with the center of the transmitter about 55 inches above the floor. This distance is an average height and may be varied according to the wishes of the subscriber. There is no objection to mounting a wall set low enough so that a user may sit on a chair to talk over it.

When a telephone is to be located on a desk in either an office or a residence it is always best if possible to mount the bell box on the wall and locate the desk close enough to it to prevent a passageway. There are many cases in large offices that this practice is not possible as desks are located in the center of rooms. In such cases it will be necessary to bring wiring either up through the floor, drop it from the ceiling or run it from the nearest baseboard over the floor to the desk protected by suitable moulding. The floor moulding plan is perhaps the neatest and best to meet this condition. Wood moulding can be used for this purpose, but I believe a much neater and more serviceable arrangement is to use national metal moulding which can be purchased even more

(*Continued on page* 35.)

Our Engineering and Management Course

General Features of Magneto Central Office Equipment Are Described in This Article, the Third Chapter in a Course of Technical Instruction Prepared for Telephone Engineer by B. C. Burden, Transmission Engineer, Lincoln Telephone and Telegraph Company

General

Previous articles in the January and February issues discussed the theory and arrangement of subscribers' instruments and magneto switchboards.

This article will be devoted to the general features of a magneto central office.

It should be borne in mind in any study of the basic theory of arrangement of telephone apparatus that there are usually many variations from that set up in the study, but a thorough understanding of the fundamentals will permit one to readily become familiar with these variations when they are encountered.

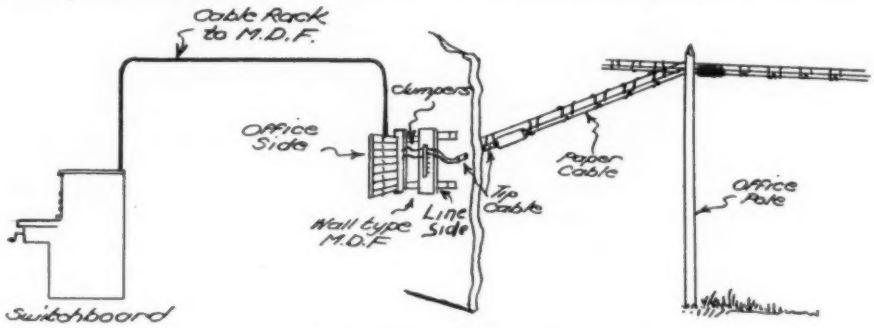


Fig. 1—Small magneto office arrangement

Arrangement of a Magneto Central Office

In order to fix in mind the part each item plays, let us separate the component parts of office equipment. These are:

1. The switchboard.
2. The line cable, and cable run to the main distributing frame.
3. The main distributing frame (commonly referred to as the m.d.f.)
4. The central office ground.
5. The cable entrance.

The Line Cable and Cable Rack

In a magneto office all switchboard equipment is contained within the switchboard cabinet and the only external wiring usually required is a pair of wires for each subscriber's drop and jack circuit, and a single pair for a power ringing machine, if one is used. This external wiring is connected to the m.d.f. by means of No. 22 gauge B. & S. copper twisted pair wire formed into cables of 50 to 100 wires. In some cases these cables carry only 20 pairs. The insulation of the conductors consists of either a coating of enamel, one layer of silk and one of cotton, or a tinned conductor with two layers of silk and one of cotton.

The core of these cables are waxed and moisture proofed and are covered with a heavy outer braid which is painted with a gray flameproof paint. Fifty pair cables or smaller are usually provided with one spare pair, and over 50 pair are provided with two spare pairs. These spare pairs are used to replace any pair which may go bad in service.

The switchboard end of the line cable is arranged in a "laced form" so that each pair of wires may be connected to its associated line jack in a uniform manner.

The line cable to the m.d.f may extend from the base or the top of the switchboard cabinet. If the cable is placed under the floor it should be adequately protected against moisture and mechanical damage.

Where it is placed overhead, a supporting rack should be used. This usually takes the form of a heavy channel iron, painted black, and equipped at the m.d.f. and switchboard with mounting brackets.

The cable is fastened in the channel of the rack and presents a very neat appearance. Figure *1* illustrates the appearance of the cable run between switchboard and m.d.f. where an overhead rack is used.

The Main Distributing Frame

The main distributing frame consists of an iron frame work on which is mounted connecting blocks and protectors. Figure *2* shows a typical wall type m.d.f. suitable for the small office. Figure *3* illustrates the floor type of main frame such as is used in common battery exchanges and in the larger magneto offices.

The main frame in a magneto office may be thought of as the connecting link between inside and outside lines. It serves two primary purposes, which are:

1. It permits connecting any inside circuit to any outside circuit.
2. It protects the central office equipment from foreign currents, such as lightning or crosses with power lines.

The side of the frame to which the outside circuits are connected is termed the "line side," and the side to which the switchboard is connected is known as the "office side."

Main Frame Protectors

Figure *4* shows the schematic circuit of a subscriber's line passing through the main frame. It will be noted that the protection consists of a 7 ampere fuse, a heat coil, and a lightning arrestor.

The purpose of the fuse is to open the circuit leading to the switchboard when a greater current than some predetermined value flows. This prevents equipment being burned out, or a fire started should power and telephone circuits become crossed.

The heat coil is another form of fuse, but serves a different purpose than the 7 ampere fuse. Its purpose is to protect the central office equipment against currents which are of too low a value to operate the 7 ampere fuse, and yet which, if allowed to flow for a prolonged period, might start a fire, due to overheating of drops or other equipment. These coils consist of a heating unit and an operating element held in place by solder.

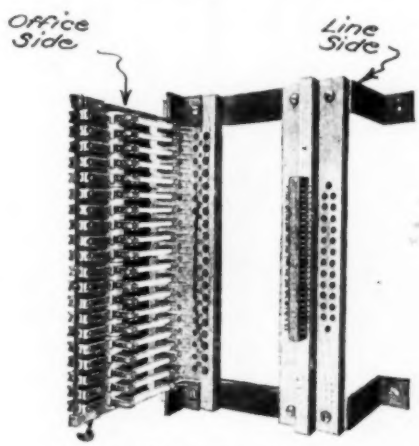


Fig. 2—Wall type main frame

The coil is so proportioned that a small current flowing for a considerable length of time will cause the solder to melt and release the operating number which is arranged to open the line towards the equipment and ground the incoming line.

The resistance of present-day heat

coils ranges from 3 to 4.5 ohms, but old style coils were much higher than this.

The lightning arrestor, or open space cutout as it is more properly called, consists of two carbon blocks insulated by means of a thin mica separator. One of the blocks is connected to the line wire and the other to the ground. Their purpose is to shunt or by-pass to ground the major part of the high potential power or lightning voltage which may be set up on a telephone circuit.

It will be observed that the open space cut-out is placed on the office side of the fuse so as to cause the fuse to blow in the event a considerable current flow takes place across the gap.

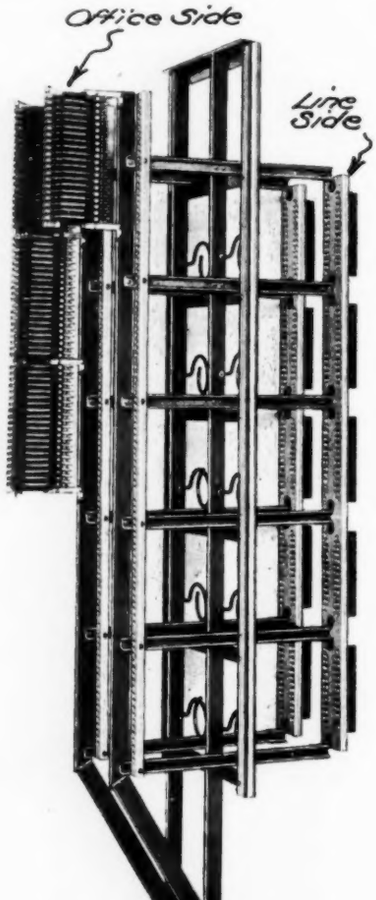


Fig. 3—Floor type main frame

The air gap is usually from .004 to .008 inches.

For various reasons it has become the practice to discontinue placing 7 ampere fuses for central office equipment protection, and many of the newer installations consist of heat coils and open space cutouts only.

Cross Connections

It is usually the practice to terminate the outside circuits on ordinary terminal blocks, while the switchboard line circuits are terminated on the protector side of the frame. The cable from the switchboard is connected to the protectors so that they number consecutively, usually starting at the top and numbering down, or from left to right. The corresponding switchboard jack number is generally stenciled in a conspicuous place on every tenth or twentieth protector so that any desired line may be quickly located at the protector side of the frame. The number of every tenth or twentieth outside pair is likewise stenciled on the line terminal blocks. It is customary to number outside cable pairs consecutively. That is, if the total number of outside cable pairs terminated were 300, the count would run from 1 to 300.

As there is always a much larger number of outside circuits than switchboard drops and jacks, it is necessary to cross-connect by means of twisted pair jumper or cross connection wire, each subscriber's line with its associated switchboard drop and jack.

The wire generally used for this purpose is a flameproof twisted pair No. 20 or 22 B. & S. gauge enameled copper wire, which is insulated with several servings of silk applied in opposite directions, and covered with a closely woven cotton braid which is made flameproof by means of chemical impregnation.

Cross connections must be run in an orderly and uniform manner between the office and line side of the frame, otherwise it would soon become impossible to place or remove one without a great deal of trouble. Insulated rings are provided through which jumpers are routed.

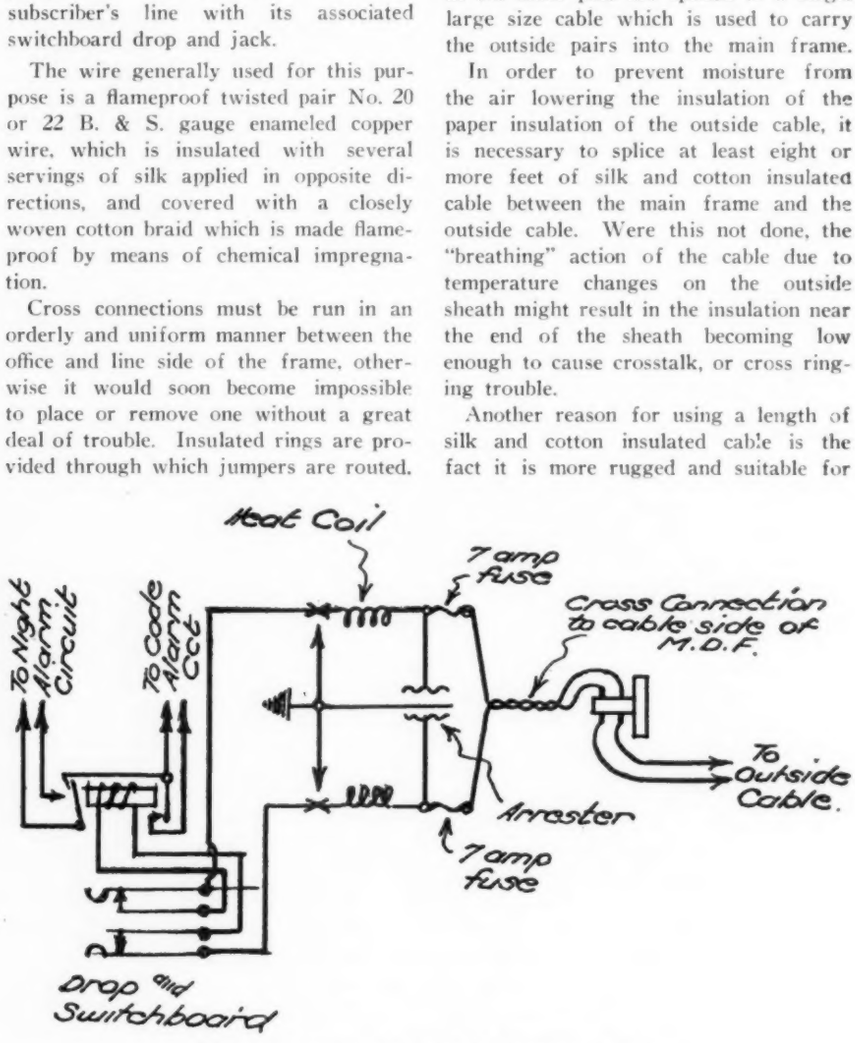


Fig. 4—Complete line circuit (magneto office)

Connection to the terminals at each end is made by soldering the wires directly to the lugs, as shown in Figure 4.

The Entrance Cable

The entrance cable may enter either aerial or underground. While the majority of the older offices have aerial entrances, the present tendency is to bring the outside cables in underground. This presents a much neater and more businesslike appearance, and usually presents fewer construction difficulties than does an aerial entrance.

An aerial entrance may be made in a variety of ways, but the typical practice is to extend the outside cables to what is known as the "office pole" from which they are carried to the point of entrance by means of a supporting strand fastened to the office building. If the office pole is within ten or fifteen feet from the point of entrance, a single pipe or a pipe ladder arrangement is fastened to pole and building and used to support the cable.

These two methods are illustrated in Figure 5.

All of the outside cables terminating at the office pole are spliced to a single large size cable which is used to carry the outside pairs into the main frame.

In order to prevent moisture from the air lowering the insulation of the paper insulation of the outside cable, it is necessary to splice at least eight or more feet of silk and cotton insulated cable between the main frame and the outside cable. Were this not done, the "breathing" action of the cable due to temperature changes on the outside sheath might result in the insulation near the end of the sheath becoming low enough to cause crosstalk, or cross ringing trouble.

Another reason for using a length of silk and cotton insulated cable is the fact it is more rugged and suitable for terminating than would be paper insulated conductors. The length of cable so used is referred to as the "tip cable."

The "tip cable" splice should preferably be placed outside the building unless this would involve too long a length of

tip cable. (Tip cable is much more costly than paper cable.)

The cable is carried through the building wall in a short piece of conduit which is usually sealed by means of some plastic compound. The cable in the building is usually fastened to the walls by means of cleats and where a neat appearance is desired, is covered with a stained wooden cover.

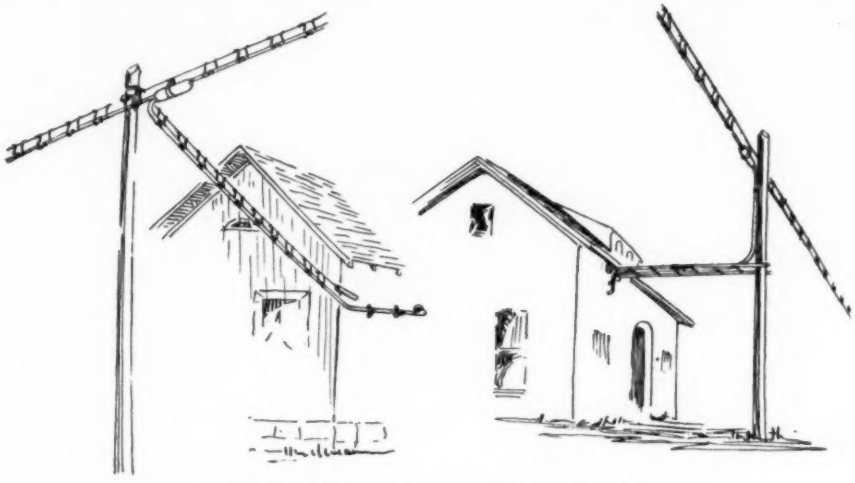


Fig. 5—Office cable entrance arrangement

At the point the cable hits the frame the lead sheath is removed and the wires sewed into a neat form and terminated on the line side of the frame.

The Central Office Ground

A good ground is essential in any telephone exchange, and is particularly essential in an exchange which is furnishing grounded service with one side of the line grounded at the m.d.f. Failure to provide a good ground in the latter case will result in severe crosstalk due to the common connection of all subscribers' lines to the same ground.

A good ground is one which has only a few ohms resistance with respect to the surrounding earth.

In other words, we may think of the earth as a gigantic conductor of negligible resistance if we can make a low resistance contact with it. Merely driving a rod in the earth will not insure that this contact resistance will be low.

Those factors which influence the resistance of the ground electrode resistance are:

1. Amount of electrode surface in contact with the earth.
2. Depth of electrode.
3. Conductivity of the soil surrounding the electrode.

It was formerly the practice to bury a large copper plate five feet in the earth and surround this with a large amount of charcoal. Connection between the main frame grounding lug and the copper plate usually consisted of a No. 0 strand copper wire. While this made a fair ground it has been found that a ground consisting of three or four ¾" galvanized pipes placed six to ten feet apart, and driven six to eight feet in the ground, if connected together, make an excellent ground with the advantage that the connection between the ground wire and ground electrodes is accessible for inspection, which is not true of the buried plate type of ground.

The ground is usually placed in the basement of the telephone office near the outside building wall. Where this is not practicable an outside ground is used. Care must be taken to run the ground wire in as direct a line as possible and to avoid all kinks and sharp turns as these tend to reduce the effectiveness of the ground in connection with lightning protection.

NEW MEXICO TELEPHONES TO BE IMPROVED

A total of $925,000 will be expended during 1931 by the Mountain States Telephone and Telegraph company for the improvement and extension of telephone service in New Mexico and El Paso, Texas, according to President F. H. Reid.

"We are proceeding with this substantial program of construction to provide for the expected need of tomorrow as well as to meet today's demand," Mr. Reid said. "Forecasting future growth and building in advance to meet that growth is one of the hazards of the telephone business. Naturally, this program indicates our faith in a return to normal business in New Mexico and El Paso county."

An important part of the 1931 construction program provides for a wider and more satisfactory local service for the communities served by the Mountain States company.

In addition to the expenditures for construction, other expenses of the company in New Mexico and El Paso county in 1931 will be such items as wages, rent, and taxes.

Of the total expenditure for new telephone construction about $225,000 will be for improvements and extensions to long distance facilities. The principal long distance projects in New Mexico and El Paso county include copper long distance facilities between Clovis and Fort Sumner and between Fort Sumner and Santa Rosa; new circuit between El Paso and Las Cruces; additional switchboard section and subscribers' lines in Clovis; toll entrance cables in El Paso; copper circuit between Roswell and Artesia; toll entrance cable in Las Cruces; toll entrance cable in Las Vegas and rerouting toll lines because of highway changes.

GROWTH IN TELEPHONE TOLL SERVICE

The human yearning to talk with persons many miles distant has boosted toll telephone service 67 per cent in the last five years, until at present a connection can be made with 85 per cent of the world's telephones.

James L. Potter, electrical engineering faculty member of the University of Iowa, points to the rapid expansion of the toll service as one of the chief achievements of telephone companies.

Maintenance of the present rate of increase, he said, will mean that by 1933 there will be 10,000 circuit miles of cable, 2,400,000 miles of open wire line, and 1,250,000 miles of carrier line.

It is due to betterment of equipment and service that the number of toll messages per telephone has grown despite the continued increase in number of phones, Potter believes. Now, during 95 per cent of the phone calls, the caller stays at the instrument until the distant person replies, the average time for reaching the party having been cut to about a minute from seven minutes, the time of 1920.

Overseas service, now slightly more than four years old, is sharing in the expansion process, necessitating the installation of new radio telephone channels to handle the traffic. By 1933, the Atlantic ocean will be spanned by six communication channels—three short and two long wave radio telephone channels, and one cable circuit, the university engineer said.

The cable circuit, first to cross the Atlantic ocean, will improve service greatly, since storms and electrical disturbances now make the radio telephone useful only 75 per cent of the time.

A new telephone building, new dial system, and new intercity copper lines are included in the year's program for the West Coast Telephone Co. in Sedro Woolley, Wash., according to the district manager.

VACUUM TUBE THEORY AND PRACTICE

SUBJECT: VACUUM TUBE VOLTMETERS

General

Voice currents in telephone circuits cannot be readily measured with ordinary alternating current measuring instruments, such as are used for measuring the voltage and current of power circuits.

There are three reasons for this. In the first place the voice frequency is variable and quite high compared to commercial power frequencies and the ordinary "vane type" A.C. meter is not suitable for operation at these frequencies. Another difficulty in measuring voice currents is the low values of currents and voltages ordinarily involved. The third reason why the magnitude of telephonic voice currents cannot be determined by ordinary means is the high resistance through which these currents may be considered as operating.

All of which brings up the question, "What methods, if any, can be used for quantitatively determining the magnitude of voltages and currents of voice currents in telephone circuits?"

There are three arrangements by which this may be accomplished, all of which are based on changing the A.C. current to direct current and measuring on a sensitive direct current meter. It should be noted that D.C. meters capable of measuring very small currents and voltages can be easily manufactured, but this is not true for A.C. meters. The three methods by which small alternating currents and voltages can be measured are:

1. The Vacuum Tube Voltmeter.
2. The Thermo-Couple and D.C. Meter Method.
3. The Copper-Oxide Rectifier Type Meter.

Figure *1* illustrates the various types (excepting vacuum tube voltmeter) of A.C. meters.

This and several succeeding articles will be devoted to the theory and application of the three methods listed above, by means of which quantitative measurements of voice frequency currents and voltages may be made. All those interested in a practical means of making transmission tests on lines and equipment are urged to study these articles carefully, as several practical and comparatively inexpensive test units which can be made by anyone, will be described.

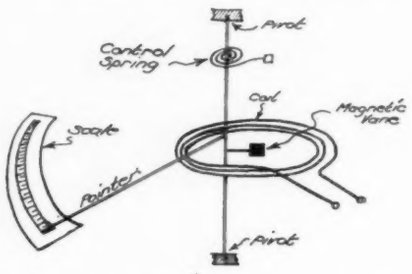


Fig. 1 (a)—Magnetic vane type instrument. When current is passed through the coil, the magnetic vane is attracted to inner edge of coil where it embraces a maximum number of lines of force. This meter is not suitable for extremely small currents or voltages.

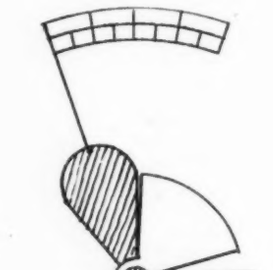


Fig. 1 (b)—Electro-static voltmeter. These meters operate by the attraction of two thin aluminum plates for each other. One of the plates is pivoted so as to move a needle over a calibrated scale. They are useful only for high voltages.

The Vacuum Tube Voltmeter

A vacuum tube voltmeter consists essentially of a three element vacuum tube, a sensitive direct current micro-ammeter, and plate, grid, and filament batteries arranged in the simple circuit shown in figure *2*. The circuit is so arranged that if the voltage to be measured is connected to the grid circuit of the tube, the magnitude of this voltage can be determined from the plate meter deflections.

The theory of operation of this type meter is as follows: The grid bias battery C is adjusted by means of the potentiameter R_1, so that the tube operates on the lower bend of the grid voltage-plate current curve as shown in figure *3* (for explanation of this curve see January, 1931, TELEPHONE ENGINEER). Now, if the input terminals are connected to an alternating current circuit whose voltage is to be measured, the increase in plate current when the positive half cycle of the input voltage is impressed on the grid will be much greater than the decrease in plate current when the negative half cycle is impressed. This will result in a net increase in plate current which

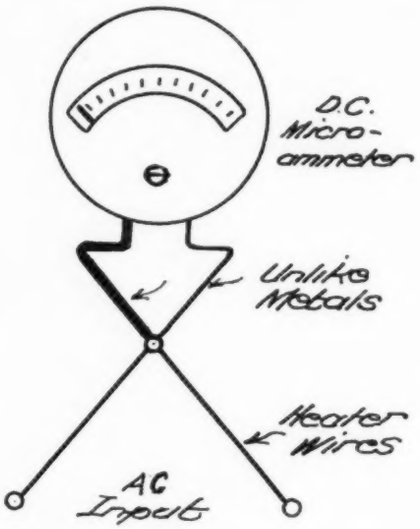


Fig. 1 (c)—Thermo couple type meters. These meters consist of a junction of two unlike metals held together with a special solder. When the junction is heated by passing alternating current through the heater wire, a small e.m.f. is generated which indicates on the d.c. meter the magnitude of the current or voltage of the circuit to which the meter is connected. Small currents can readily be measured with this arrangement, however, the thermo elements are very easily burned out by current overloads.

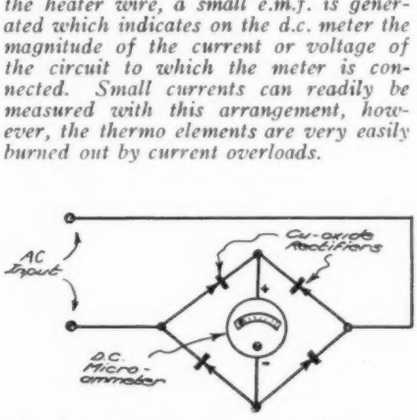


Fig. 1 (d)—Copper oxide rectifier type meters. This type meter operates by rectifying the a.c. input wave by means of a copper-oxide rectifier arranged in a bridge circuit, with a microammeter in the d.c. circuit. These meters, while not as accurate as d.c. meters, are sufficiently accurate for general testing purposes. Any frequency in the audio frequency range can be measured, and very low current values or voltages.

will be detected by the sensitive D.C. meter in the plate circuit. Inasmuch as the value of the increase in plate current depends on the magnitude of the input voltage, the meter scale can be calibrated to read in terms of volts, or under certain conditions db's rather than micro-amperes.

For those familiar with vacuum tube characteristic curves the foregoing paragraph should present a clear explanation of the operation of a vacuum tube volt-

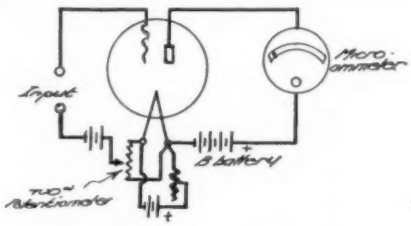


Fig. 2—Basic vacuum tube voltmeter circuit

meter. For those not familiar with these curves the explanation given may be simplified by saying that a vacuum tube voltmeter is merely an arrangement whereby the grid of a vacuum tube is made sufficiently negative so that if an A.C. voltage is applied to the grid circuit an increase in plate current is indicated on a D.C. meter in the plate circuit.

The principal advantage of the vacuum tube voltmeter aside from its ability to measure alternating current on a direct current meter, is the fact that it has a

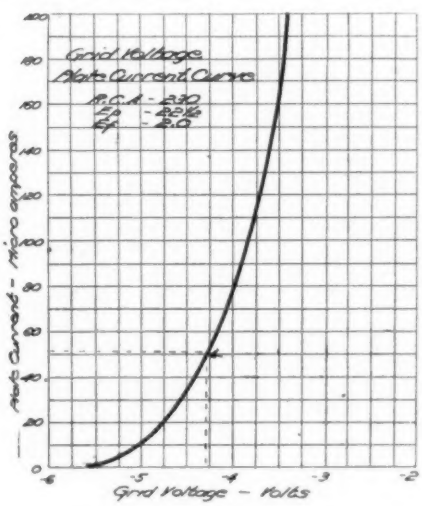


Fig. 3—Grid voltage-plate current characteristic curve RCA-230 tube

negligible effect on the circuit to which it is connected. This is true because of the high input impedance of the grid circuit at any frequency, but particularly the lower frequencies.

It should be noted that a voltmeter calibrated in volts does not necessarily insure that such a meter will indicate the correct voltage of the circuit to which it may be connected. For example, an ordinary low resistance voltmeter having a range of 0 to 200 volts (D.C.) if connected to the output of a "B" eliminator of a radio set will usually give a much lower voltage reading than is actually present at the terminals of the eliminator when the voltmeter is disconnected. The lower reading with the voltmeter connected is caused by the internal voltage drop in the eliminator due to the current taken by the meter itself. This effect is pictured in figure *4*.

The current taken by a vacuum tube voltmeter (properly operated) at voice frequencies is so small as to be unmeasurable, hence we may consider such a meter as having an infinite impedance.

Various Vacuum Tube Voltmeter Circuits

Before considering the many uses to which a vacuum tube voltmeter may be put in connection with telephone circuit and equipment measurements let us con-

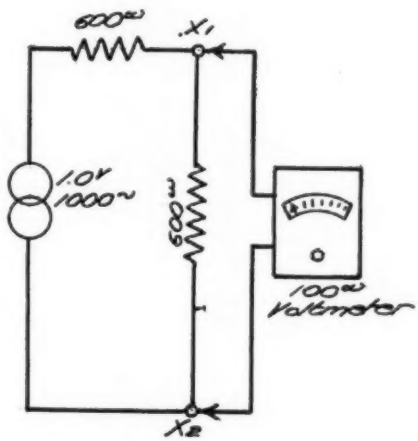


Fig. 4—Effect of voltmeter resistance on accuracy of readings. With the circuit shown the actual voltage indicated on a 100-ohm meter would be .1244 volt, whereas the actual voltage across x1 and x2 would be .50 volt. If a 5000-ohm meter were used the meter would actually indicate .47 volt.

sider the various tube voltmeter circuits that might be used.

The most common type is that shown in figure *2*, and whose operation was previously explained. This circuit, because of its simplicity and stability, is the one recommended for general telephone testing.

Another arrangement which is good and which is used in a manufactured tube voltmeter is shown in figure *5*. In this arrangement the plate meter is placed in a "Wheatstone Bridge" circuit, the four arms consisting of three equal resistances and the plate-filament resistance of the tube itself. The three resistances are selected so as to have the same resistance as the D.C. resistance of the tube at its normal grid bias. The bias is such that the tube operates on the lower bend of its characteristic curve. An alternating voltage impressed on the grid causes the plate-filament resistance to decrease thus upsetting the balance of the bridge and giving a deflection on the D.C. meter across the midpoint of the bridge. This arrangement is more difficult to build than the "regular type" and for this reason is not recommended to those who desire to construct their own voltmeter.

A third arrangement which is known as the "reflex vacuum tube voltmeter" is shown in figure *6*. This circuit is identical with those previously described except that a resistance (X) is connected in the plate circuit so that plate current

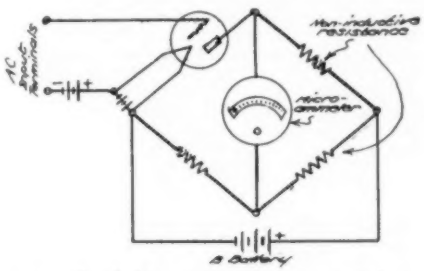


Fig. 5—Bridge type of vacuum tube voltmeter

in passing through this resistance will cause a drop in potential which will increase the negative bias on the grid. The resistance value is so selected that the plate current change is small for a given A.C. input, hence a much larger voltage range may be obtained. This type of voltmeter would be useful in measuring exceptionally high voice levels such as the output of public address amplifiers.

There are several other variations of the vacuum tube voltmeter circuit, but these are not of sufficient importance to warrant discussing here.

Calibration of Vacuum Tube Voltmeters

The vacuum tube voltmeter may be, if so desired, calibrated so that by means

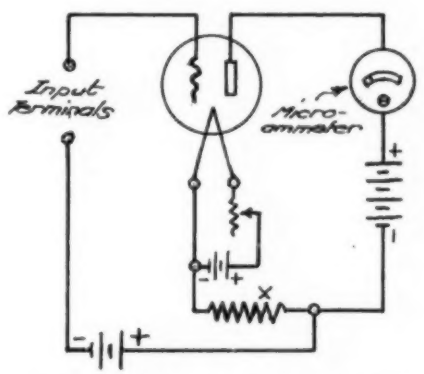


Fig. 6—Reflex type of tube voltmeter

of a conversion chart or curve the input voltage corresponding to any plate meter deflection, may be determined, or it may be used merely as a comparative or balance type meter.

There are several methods of calibrating and the method to use will depend on the facilities available. One of the simplest methods is shown in figure *7*.

It will be seen that a low voltage A.C. 60 cycles is impressed across a fixed resistance and the input circuit to the volt-

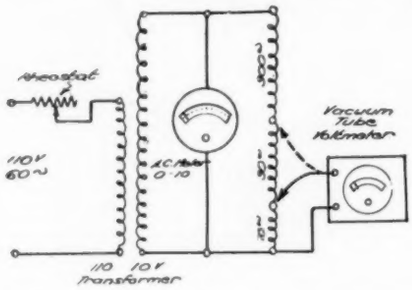


Fig. 7—Calibration of vacuum tube voltmeter

meter taken off either at the 100 ohms or 10 ohm tap. The voltage across the secondary of the bell ringing transformer is adjusted by means of a resistance in series with the primary so that voltages of from 1 to 10 volts are indicated on the low reading A.C. voltmeter bridged across the 1,000 ohms resistor.

The actual voltage impressed across the input to the vacuum tube voltmeter will be either 0.1 or 0.01 of the voltage indicated on the A.C. voltmeter. For example, if 5 volts was impressed across the 1,000 ohms resistor then the voltage input to the tube voltmeter would be $5 \times 0.1 = .5$ volt (100 ohms tap) or $5 \times 0.01 = 0.05$ volt for the 10 ohms tap. If a low range A.C. voltmeter is not available a high range meter such as 0 to 150 volts may be used by increasing the total resistance to 10,000 ohms with taps at the 1,000 and 100 ohm points.

By plotting the readings of the plate circuit micro-ammeter for the various input voltages, a curve such as shown in figure *8*, may be obtained. This curve represents the actual range of an RCA-230 tube used in a circuit as shown in figure *9*. These meters may also be calibrated to read volume level in terms of decibels above or below "zero reference level" for 600 ohm lines.

Range of Vacuum Tube Voltmeters

The voltage range of a vacuum tube voltmeter will depend on the tube used and the type of input circuit employed.

In general, the range of a single tube voltmeter is about 0.4 to 2 volts. This range is sufficient to permit using such a meter in connection with certain types of shop tests (will be described in later article) on transmitters, but is not sufficiently low to permit testing receivers or making comparison tests through pads having losses of more than a few decibels.

In order to get a high order of sensitivity, a one or two stage voice amplifier may be connected ahead of the volt-

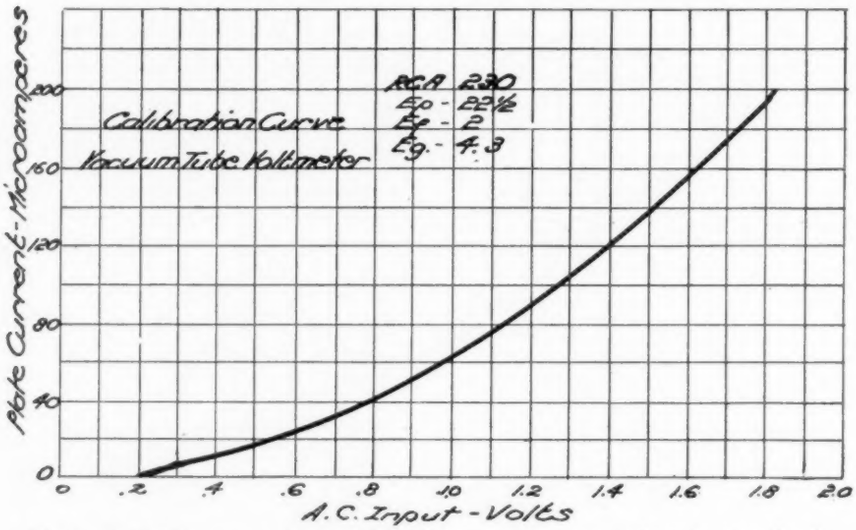


Fig. 8—Calibration curve for an RCA-230 and in a vacuum tube voltmeter circuit

meter tube. For example, a voltage gain of 15 per stage of voice frequency amplification would give for two stages a total gain of $15 \times 15 = 225$, hence, a meter with a range of from 0.5 to 2 volts would be able to read voltages as low as .002 volts. A single stage amplifier would permit measuring voltages down to .033 volts.

Such an arrangement would permit making direct reading transmission tests on both receivers and transmitters, as well as through loss pads up to 30 d.b.

The addition of amplification ahead of the voltmeter tube makes it difficult to calibrate the meter with any degree of assurance that the calibration will not change, due to the many variable elements introduced by the amplifying circuit. Also, the fact that transformers are used which cannot be expected to give the same efficiency at all frequencies in the audible range.

This fact is of no consequence, however, as practically all transmission measurements on circuits and equipment are based on "comparison testing" which utilizes the vacuum tube voltmeter merely as a sensitive balance indicator, rather than a calibrated voltage measuring device.

Figure *10* shows a commercial type of vacuum tube voltmeter manufactured by the General Radio company. This meter has a range of 0.6 to 3.0 volts and uses a 199 type tube.

Constructional Details

Figure *9* shows the circuit schematic of a two tube vacuum tube voltmeter using a Weston 0 to 200 micro-ammeter and RC.A.-230 vacuum tubes, which can easily be constructed at a relatively small cost.

Such an instrument can be used to good advantage in connection with transmission testing both on circuits and on equipment such as transmitters, receivers and repeating coils, etc.

This arrangement consists essentially of a one stage amplifier, a rectifier tube, a sensitive D.C. micro-ammeter, and an an arrangement of jacks, and resistances by means of which any desired degree of

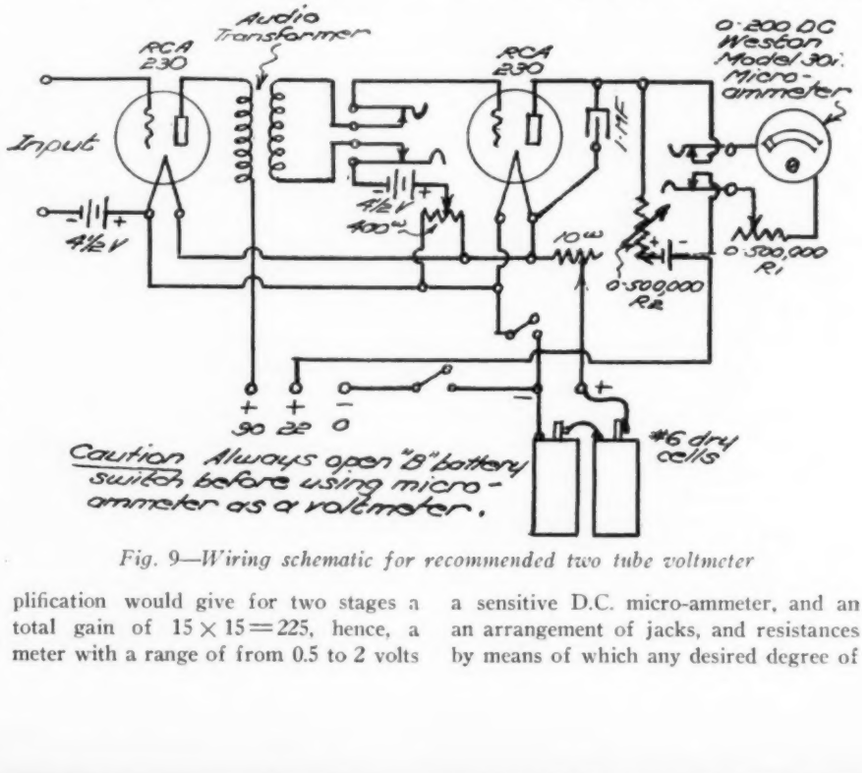


Fig. 9—Wiring schematic for recommended two tube voltmeter

amplification can be obtained, and which permits using the micro-ammeter as an external voltmeter.

When it is desired to use the micro-ammeter as an external voltmeter for checknig filament or bias voltages, a patching cord is plugged into the meter jack and the plug at the other end of the cord connected to the terminals of a single new flashlight cell. The variable resistor R_1 is then adjusted until the meter indicates 50. This calibrating process makes a six volt meter out of

Fig. 10—General radio portable vacuum tube voltmeter

the micro-ammeter and by plugging into the filament and grid bias jacks the voltages may be adjusted to the correct values. For example, if a three volt grid bias is desired, the potentiameter R_2 would be adjusted until the micro-ammeter read 100, which would be equiv-

Fig. 11—Weston microammeter

alent to three volts, as the meter was calibrated to give six volts for 200 micro-amperes deflection.

It will be noted in figure 9 that a small dry cell and variable resistance R_3 is connected across the meter terminals. The resistance is adjusted so as to pass a current from the single cell through the meter in opposite directions to the normal plate current so that the turning torque on the meter coil due to the normal plate current is just neutralized. This permits using the entire scale of the meter for input voltage deflections, and is merely an arrangement for bucking out the normal plate current.

By using small size B and A batteries, the unit may be self-contained, thus eliminating the necessity for connecting and disconnecting batteries whenever it is moved.

The following list of parts is required for the construction of a two tube unit, the total cost of which should not exceed $35.00:

List of Parts for Vacuum Tube Voltmeter

1 Weston 0-200 micro-ammeter (order from Weston Electrical Instrument Co., Newark, N. J.).

2 RCA 230 type vacuum tubes (any radio supply store).

2 UX sockets (any radio supply store).

1 Stromberg-Carlson audio transformer (order from Stromberg-Carlson company, Rochester, N. Y.).

2 Carter —0 to 500,000 ohm variable resistances No. HI-R5 (Carter Radio company, Chicago, Ill.).

3 Carter jacks No. 104 (Carter Radio company, Chicago, Ill.).

1 Carter filament switch No. 116 (Carter Radio company, Chicago, Ill.).

1 Carter —400 ohm potentiameter No. TP-400 (Carter Radio company, Chicago, Ill.)

1 Carter —10 ohm rheostat No. MR-10 (Carter Radio company, Chicago, Ill.).

1 1-m. f. condenser (any good telephone condenser).

2 4½ v. c. batteries (small size).

4 22½ small size B batteries (any radio store).

2 No. 4 or No. 6 dry cells (any radio store).

1 panel and carrying case (any radio store).

The RCA-230 type tubes were selected as they have good characteristics for the purpose used and consume only .06 amperes filament current at 2 volts. The filaments may be lighted from either 2 No. 6 or 2 No. 4 dry cells.

The Weston micro-ammeter shown in figure *11*, is a Model 301 type instrument, and is provided with buffer springs to prevent damage to the meter needle should it be violently kicked off scale. This instrument is exceedingly well built and like all Weston instruments may be relied on to be accurate. These meters are available to telephone companies at approximately $10.00 each, and may be ordered direct from the Weston Electrical Instrument company at Newark, New Jersey.

Complete kits and wiring plans, including the Weston meter (but not including batteries) may be obtained from the Lincoln Engineering company, Lincoln, Nebraska, for $35.00, also full instructions on its use in transmission testing of subsets or circuits. For those who desire to build this unit from parts obtained elsewhere, complete details, blue prints and instructions for making transmission tests are available for $1.00 postpaid. Write Lincoln Engineering company.

The next issue of TELEPHONE ENGINEER will discuss some of the many transmission measurements that may be made using the unit described above.

CARRIER CURRENTS USED IN COMPOSITE WORK

(*Continued from page 20.*)

tances are about 140 and 190 miles, respectively.

For this telegraph system a new receiving and transmitting relay had to be designed, or rather two relays. One is the 209-FA relay and the other one the 215-A relay; the former is an extremely sensitive polarized relay, while the latter is less sensitive.

In compositing, of course, care must be taken to avoid interference between the telephone, telegraph and signaling circuits. A few words of explanation may be added about the interference from the telegraph. Such interference is exerted in two ways: (1) By the "telegraph thump" and (2) by the "flutter effect." The thump is evidenced by a low-pitched noise in the telephone. The current producing the thumping may affect the signaling and cause false rings. Thumping may also be caused at the receiving end by transformer action of the relay windings. The flutter effect has its origin in the circumstance, that the rapid changes in the telegraph currents increase momentarily the effective resistance of the loading coils, whereby the attenuation in the circuit is varied at telephone frequencies.

As the metallic telegraph repeaters are distanced about 160 miles and the telephone repeaters mostly only 50 miles, the telegraph line branches are connected by means of a by-pass set to lead the telegraph currents around the telephone repeater, and an intermediate composite set is placed on either side of the telephone repeater.

Space will not permit to enter into a description of the new relays nor of the composite circuits.

Associated Telephone & Telegraph Company announces that its subsidiary, Compania Dominicana de Telefonos, has purchased from the Dominican government the telephone system in the city of Santo Domingo and toll lines connecting various other cities throughout the republic. The company will take over operation of this system immediately under terms of a forty-year concession obtained in January, 1930. This is considered an important step in the foreign development of the Associated system.

Relays Involved in Trunk Circuit Proper

The Functioning of Incoming Calls, Ringing Pre-Selected, and Plug-Up Operations Is Related by J. H. Levis, Jr., Telephone Engineer, Rochester, N. Y., in the Tenth of His Series of Articles on Straightforward Trunking, Written Exclusively for Telephone Engineer.

Incoming Call, Ringing Pre-selected, and Plug-up Operations

In the last two installments of this article the incoming call relay operations and the incoming call and ringing key relay operations were shown in functional circuit diagrams and with these operations shown, the trunk circuit proper is now prepared to be placed in the called station line and ringing started.

The functional circuit diagram shows the complete connection from the calling telephone "A" cord circuit, outgoing trunk, incoming trunk (prepared to start ringing operations) and called telephone line with harmonic party line bills and condensers.

The telephone circuits and the "A" cord and outgoing trunk circuits are shown in simplified form. They all have been described in detail in previous issues of TELEPHONE ENGINEER.

When the 16 cycle common ringing key is operated as shown in the circuit diagram in last month's installment, it will be remembered that all of the relays in the common equipment release and they are prepared to accept another trunk call in the same manner as has been heretofore described. This also applies to some of the trunk circuit proper relays, numbers ten and five. These relays do not again function unless this same trunk is called upon to again render service.

The trunk plug is now plugged into the called line and is shown in the diagram in dash lines to the called line jack, indicating connection thereto.

This operation causes the number 8 trunk plug sleeve relay to operate, causing the trunk lamp to go out, which was burning steady at the time of pre-selection of ringing by the 16 cycle common ringing key. This relay also operates the number 11 relay which cuts off the busy test, common to the tip of the trunk plug and cuts the tip of the plug through to the generator ground return on the number 7 relay. This relay also closes the 16 cycle generator from the frequency selector relays numbers 13 and 14 through relay number 5, through the generator trip relay number 6 to relay 7 and to the ring of line, through the bell circuits to the generator return circuit and to the ground. The generator proper is connected to the 40 volt negative battery lead and runs through an interrupter which periodically interrupts the generator. First ringing then silent, the silent interval also has a 40 volt negative battery. The purpose of the two batteries is for tripping the ringing control circuits off by the operation of relay number 6. It will be noted that when this relay operates a short circuit is placed around the holding winding of the number 7 relay, causing it to release.

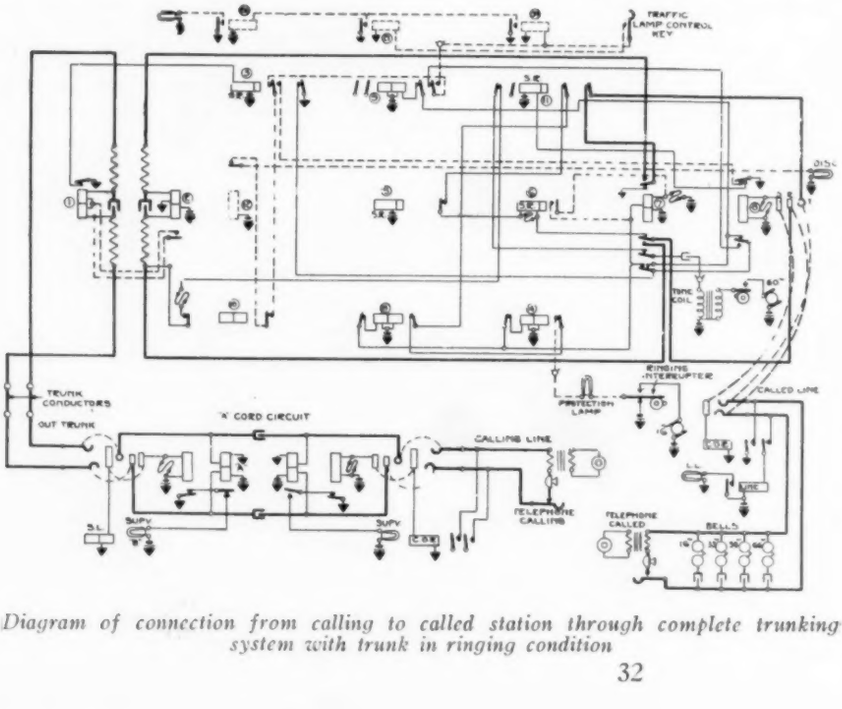


Diagram of connection from calling to called station through complete trunking system with trunk in ringing condition

The operation of relay number 6 is caused by the removing of the receiver from the hook of the called telephone, closing the line loop. (See relay function installments.)

The operation of relay number 11 closes the circuit for the reverting ringing tone signal, which was first closed at the number 7 relay. This signal passes through the number 10 relay, the non-inductive resistance coil to the repeating coil in the trunk and to the battery winding of relay number 2. At relay number 7 the tone passes through a common condenser and then to the common tone repeating coil to battery. The power side of the tone coil has interrupted 50 cycle generator, which is used as a monotone reverting ringing signal. The complete release of relay number 7 removes the ringing energy and the reverting tone signal. The numbers 13 and 14 relays also release, because they are no longer needed in this connection, thus battery energy is conserved.

The line loop to the called station is closed and relay number 7 is released. The talking circuit is now established up to the trunk side of the repeating coil and the number 2 relay is operated. This relay closes the contact that shunts out the high resistance winding of 10,000 ohms on relay No. 1, which causes the "A" relay in the "A" cord circuit to operate, extinguishing the "B" supervisory lamp in the "A" cord circuit. This indicates to the "A" operator that the stations are in communication.

The number 2 relay in the trunk circuit furnishes transmitter battery to the called telephone.

The number 1 relay continues to be operated through its low resistance winding from the battery through the "A" relay in the "A" cord circuit at the distant office. This is necessary as many relays in the trunk circuit proper are held operated and must remain so until the receiver of the called station is replaced on the hook, causing the line loop to open and the number 2 relay to release and again placing the 10,000 ohms of the number 1 relay into the trunk loop back to the "A" relay in the "A" cord circuit. This allows the "A" relay to release again, lighting the supervisory lamp, indicating to the "A" operator that the called party through the trunk

(*Continued on page* 34.)

Characteristics of Strowger Relays*

Discussion of the Important Points in the Design of Relays, Including Some of the More Obvious Faults Which Must Be Guarded Against in Their Construction

By K. W. GRAYBILL
Research and Development Department, Automatic Electric Inc.

From the very beginning of telephony, small relays have been used to perform circuit-switching operations in telephone switchboards. Within the last few years many of these relays, although developed primarily for telephone circuits, have been found useful in industrial operations outside the field of telephony, as well. They are now being employed in signalling and communicating systems operated by changes in temperature, humidity, light, sound, or almost any other physical condition; and new uses are continually being found for them. A few

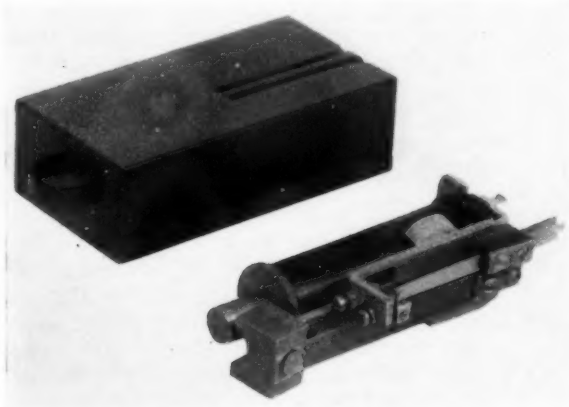


Fig. 1

of these many types are shown in Figs. 1 to 4, inclusive.

In the development of relays for such specialized purposes, the designer is working within narrow margins to meet certain definite requirements. It is the purpose of this article to outline these requirements, and to show the chief factors that enter into the design of a relay which is to meet them.

A relay is, basically, a switch designed to operate when the circuit to its winding is opened or closed. To successfully accomplish this switching operation, the relay must be designed with three points in mind:

1. The contacts must perform their assigned function without failure.

2. The relay coils and adjustments must be chosen to assure operation under the probable extreme operating conditions.

3. The relay must be mechanically durable and reliable in operation.

Since the primary function of a relay is to close circuits through its contacts, those factors which assure reliable circuit closure deserve first thought. Variations in contact pressure, in contact deflection or follow, in contact size, and in contact material—all of these have their effects, and must be considered.

Many tests have been conducted on horizontal type relays to determine the effect of these variations. One of these tests consisted in the operation of one hundred pairs of contacts for each condition of pressure, follow, etc., for many thousands of times, the total number of contact failures in each group being recorded. The relays under test were mounted on the roof of a factory building and covered in such a manner as to shut out rain, but permit smoke and atmospheric dust to circulate freely around them.

This equipment was exposed to a severe snowstorm, with the result shown in Fig. 5. (The cover sections have been removed from one side of the upright in the photograph, to show the amount of snow which entered the upright during the storm.) The relays shown were operating at the time the photograph was taken, with no more trouble occurring in most of the test groups than had been occurring before the storm.

It is not possible to discuss all the results of these tests here, but some of the results of variation in contact pressure which are of the most interest can be given. Three groups, each consisting of one-hundred pairs of make contacts, were operated with contact pressures of 5, 15, and 30 grams, respectively. During the first half million operations the first group had 4,500 failures per pair of contacts; the second group had 213 failures per pair, and the third group had only 2 failures per pair. The test conditions in this case were, of course, much more severe than any operating conditions ever encountered. However, the advantage of adequate contact pressure is strikingly proved.

Adequate pressure breaks down ordinary deposits of dust or dirt, and makes an electrical contact which has a low and constant resistance. Light contact pressure makes it possible for small particles of atmospheric dust to hold the contacts open electrically when they appear to be mechanically in contact. As the contact pressure becomes very low, contact resistance tends to increase and also becomes subject to continual variation due to vibration set up by near-by apparatus. This variation may be harmless in signalling circuits, but is serious in voice-transmission circuits because it produces changes in the amount of current flowing, and these changes are audible as noise to the listener.

The contacts on relay springs are ordinarily made of silver, gold, platinum, or similar precious metals, or of alloys of these metals. These metals are used, in spite of their high cost, because they do not tarnish readily under atmospheric conditions, and do not melt readily at the temperatures caused by the arcs which occur when they open circuits. Common or base metals such as copper or aluminum, which might otherwise be good conductors, tarnish quickly under atmospheric conditions, by forming chemical combinations with the carbon dioxide or oxygen, in the air, thus producing films which offer high resistance to the flow of current. The so-called precious metals tarnish very slowly or not at all,

Fig. 2

and the tarnish which forms (silver sulphide, for example) is readily broken down by adequate contact pressures. In exceptional cases it is possible to use base metals for opening circuits, if contact pressure can be very heavy so as to break down tarnish during each operation, and if the circuit to be opened does not cause much arcing.

A discussion of contact reliability would not be complete without some mention of contact cleanliness. It is desirable that relays be covered so as to prevent dust from settling on the contacts, as contact failure can be caused by a large deposit of dust or dirt, regardless of contact pressure or materials. If dust-proof cov-

*Editor's Note: This is the first article of a series by Mr. Graybill dealing with relay characteristics. The second article will appear in the next issue.

ers cannot be employed, periodic cleaning with carbon tetrachloride is necessary to guard against contact failure from this cause.

The second point in relay design, reliability of operation, is secured by specifying suitable coils and adjustments. A factor of safety must always be provided, by using coils which, even with the smallest amount of current expected under extreme operating conditions, will develop a surplus of power over that required to operate the relay. Furthermore, the coils must not become too hot when subjected to continuous operation. Heating of coil windings raises their resistance, and, if excessive, it may result in a reduction of current sufficient to entirely counteract the calculated operating factor of safety. Excessive heating may also injure the insulation on the wire, and cause open—or short—circuits.

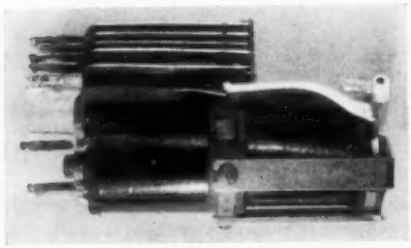


Fig. 3

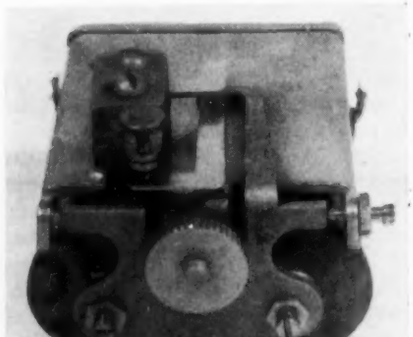


Fig. 4

Another factor which frequently enters into the consideration of this second point is the necessity for a certain definitely limited operate or release time. Relays cannot be built commercially to provide *exact* operation or release times, but coils and adjustments can be specified which will keep the variation within definite limits.

The third important consideration in designing relays is the selection of parts and adjustment requirements to assure durability. This means that the relay must be able to operate without losing its adjustment and without excessive wear, either of which might make operation unreliable.

When the loads to be broken by the relay springs are heavy enough to cause arcing, the durability of the spring contacts becomes a problem. As some precious metals have higher melting points than others, and will therefore wear away more slowly in arcing circuits, careful selection of the contact material, with proper consideration of the load to be broken and the frequency of operation, will help to assure maximum durability for the contacts.

The durability of relay coils in service must also be considered. It is affected by the amount of heat developed by the current in the winding, by the amount of moisture in the air (which might aid in establishing a destructive electrolysis), and by the presence of high-voltages windings can safely stand varies, of course, with the kind of insulation on the wire. The insulation may be enamel alone, single silk, double silk, or enamel and single silk together. The type of insulation necessary to assure a durable product is determined by the maximum voltage in the circuit of the winding, and by consideration of the effect which short-circuited turns will have on operation. In any case, coils must be designed so that, even under the probable extreme operating conditions, they will not attain temperatures which would destroy the wire insulation.

If relays are to be operated in climates where the relative humidity is constantly high, and are to be used in such a way that the air cannot be dried out by the use of heat, it is sometimes advisable to impregnate the coils, or to otherwise seal the windings so as to exclude moisture. This will prevent excessive electrolysis within the coil windings. It is also desirable, wherever possible, that the negative rather than the positive terminal of the battery be normally connected to the relay coils, so that if conditions occur which promote electrolytic action, the coil windings will not be seriously corroded.

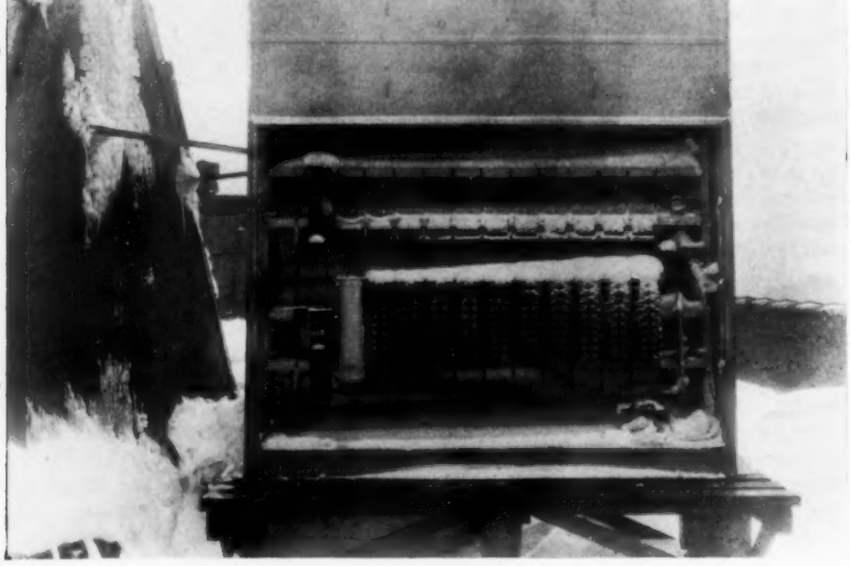


Fig. 5

RELAYS INVOLVED IN TRUNK CIRCUIT PROPER

(*Continued from page 32.*)

system has finished conversing, and when the receiver is returned to the hook, the supervisory lamp on that end of the "A" cord circuit lights, giving a signal and with this signal both supervisory lamps are lighted. The "A" operator withdraws both plugs from the jacks, extinguishing the cord lamps, and when the plug is withdrawn from the outgoing trunk jack the battery from the "A" cord circuit, which held the number 1 trunk relay operated, releases. The number 3 relay of the trunk now releases, causing the trunk lamp to re-light with same in the called line jack. This is now a "B" disconnect lamp. The lamp circuit at this time is from the lamp through relays number 12-10-3-8. The first three relays are released and when relay number 8 operates the number 9 lockout relay also releases because the ground at number 3 is open. Relay number 9 was held on its locking winding. The circuit of the trunk lamp in the diagram is shown in dash lines. The shorting of the 10,000 ohm relay number 1 from relay number 2 and the shorting of number 7 relay from number 6 relay are also shown in dash lines.

In connection with the lamp portion of the circuit there is another possible condition that can exist. If another call is passed through this same trunk while the trunk plug is in a line jack and while a disconnect is showing (as just described) in which case the outgoing end at the "A" office is available

for use, the trunk lamp will at once go out as number 1 and number 3 relays re-operate, shifting the lamp circuit at re-which might result in short-circuits.

The maximum temperature which coil lay number 3 into the traffic lamp control circuit through number 9 relay, which is now operated, to the high resistance relay number 34. This in turn lights the 1-20 or 21-40 trunk pilot lamps from relay number 26. The "no-lamp" condition on the trunk at this time only exists when a call is being handled by the "B" operator on another trunk. If the "B" operator is not busy she will immediately answer the new call and the trunk disconnect lamp will at once start to flash the same as when there is an incoming call with the plug down, as described in previous issues of TELEPHONE ENGINEER.

Should it be desired to have the trunk disconnect lamp stay lighted when a new call comes in and not have it cut into at once, the traffic lamp control key is operated (there being a key for each 20 trunks). This places the low resistance relay number 21 across the number 34 high resistance relay, giving a low resistance ground circuit to the trunk lamp, in which case the lamp lights. In this case the trunk plug probably can be removed from a line jack before it is again re-taken at the "A" end.

It again can be mentioned that the real purpose of the traffic lamp control circuit is to prevent all new unanswered calls ahead in the position from showing at all and to cause all regular disconnects to show. This eliminates possible confusion and should an accidental momentary disconnect take place at the "A" end and is again re-taken, the trunk lamp will be out, thereby preventing an actual pull-down by the "B" operator. With or without a steady "B" supervisory lamp the stations may converse, but in either case the sequence cut-in circuit will pick this trunk up and the trunk lamp will flash, but the "B" operator, hearing a conversation, will not remove the trunk plug, but instead will operate the non-ring common key and will retire from the circuit, restoring it to its proper condition.

The reader is referred to the October, 1930, issue of TELEPHONE ENGINEER for the complete circuit diagram of the straightforward trunk and its complement features.

DETAILS OF INSTALLING THE SUBSCRIBER'S SET

(*Continued from page 24.*)

reasonably than the wood moulding. Wire should be well protected with tape where it enters and leaves any type moulding.

When a desk set is located on a large rug, a condition which will be found in many private offices, it is generally possible to use small single wires tacked to the floor under the rug. The wire can generally be brought through the rug at a seam near the desk leg or a hole can be made with a sharp pointed instrument by separating the weave without damage to the rug. Permission should always be obtained from the owner before attempting an installation of this character.

The best location for a bell box on a desk will generally be under and at the rear where it is out of the way, but some object to this arrangement as they claim it will not give enough cord length. The bell box can be mounted on either end of a desk, but when possible should be back of center.

Methods of Mounting Sets

If a set is to be mounted on a plaster, brick or tile wall the best plan is to make use of a suitable backboard. Screws can be used to mount the backboard to a plaster wall, screws and lead anchors on a brick wall and toggle bolts on tile. The set can be fastened to the backboard with the ordinary No. 8 round head screws. In mounting sets on desks care should always be taken not to use screws long enough to interfere with the operation of drawers. Some difficulty is experienced by the average installer in mounting bell boxes on the modern metal desks. The best plan, I believe, is to drill holes and fasten the box to the desk with stove bolts. Two bolts are generally considered sufficient for this purpose.

Correct Installation Methods

The observance of these simple rules in the installation of telephone sets will materially reduce trouble reports later. While well-trained troublemen are a necessity in any exchange their need is not so great in an exchange where good installers observe correct methods. We all know of numerous subscribers' stations which have never been visited by a troubleman, and we also know that in such cases a good installer placed the instrument in service.

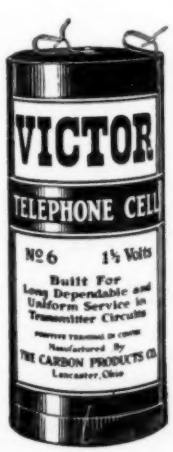
Let Victor Cut 1931 Cell Bills

TEST a single case of Victor Telephone Cells by actual service on the line. Then compute their cost per month for your whole system and compare it to your present telephone cell expense.

Victor cells will sell themselves.

Many of the largest independent telephone companies in the country are operating in 1931 under reduced drycell expense because of Victor's longer life, finer service and greater uniformity.

Order a case today and let line service be the judge.



VICTOR
TELEPHONE CELLS
"THE CELL THAT SELLS ITSELF"

Victor Telephone Cells are manufactured by the BOND ELECTRIC CORPORATION, CARBON PRODUCTS DIVISION, LANCASTER, OHIO; Executive Offices, Jersey City, N. J.; Branch Offices, Chicago, Ill. and San Francisco, Calif.

UNIQUE FURNACE
GASOLINE—KEROSENE

PATENTED ARRANGEMENT FOR DISLODGEING COIL WITHOUT TEARING DOWN FURNACE
PATENTED SEAMLESS TUBING COIL GENERATOR
IMPROVED ONE PIECE BURNER
HAND HOLD FOR CLEANER ONE TURN CLEANS ORIFICE
AUTOMATIC ORIFICE CLEANER
AUTOMATIC PUMP INSIDE TANK
18 GUAGE STEEL TANK WELDED BOTTOM

10 MINUTES TO MELT 50 lbs. OF SOLDER

But—more important—

The experienced cable splicer will be surprised at the length of time it will remain in the field without attention!

Literature?

UNIQUE MANUFACTURING CO., Inc
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OUT-OF-TOWN SALES INCREASED
Selling cost decreased . . . through this Telephone Merchandising Plan

THE TELEPHONE is helpful at all times in transacting inter-city business, but it is especially valuable when a definite plan is followed.

An automobile distributing firm adopted a Long Distance merchandising plan presented by the local Bell Company. This plan included direct selling to dealers in three states by telephone; the use of Long Distance advertising material to cover 2000 potential parts customers; and the training of the firm's personnel on telephone sales work.

The general manager writes: "We have been very successful in increasing our sales volume materially since the start of the plan; and our selling cost has decreased beyond our fondest hopes."

A machinery company on the west coast had bought the output of a bankrupt concern. A telephone representative suggested a Sequence Calling Plan to dispose of the equipment. In three days, 256 customers in four states were solicited by telephone, and $6000 worth of machinery was sold at a sales cost of about 1%.

Your local Bell Company has trained men who will gladly help you devise a telephone merchandising plan to fit your particular needs. Long Distance charges are surprisingly low: St. Louis to Indianapolis, $1.10. San Francisco to Philadelphia, $8.75. Cleveland to Pittsburgh, 70 cents. These are station-to-station day rates; evening and night rates are still lower. Develop your inter-city business by telephone . . . *quick* . . . *inexpensive* . . . *most effective.*

SHOWING THE BUSINESS MAN THE WAY TO

lower sales cost

THE MOST generous margin of profit between production cost and sale price can be quickly wiped out if selling costs are excessive. Any service designed to cut selling costs materially is sure of a warm welcome in the world of business—especially when general conditions make economy imperative.

Many manufacturers have employed special telephone merchandising plans with conspicuous success in cutting selling costs. Their actual experiences are related in advertisements similar to the one on the opposite page. They include direct quotations and definite figures. They are told in simple, straightforward, convincing fashion.

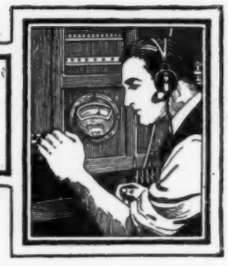
Readers are referred to the local telephone company for assistance in devising the plan best suited to their individual needs. Specific rates between cities are quoted to prove the relative economy of the plan and to provide some basis for its consideration.

This advertising is reaching business and industrial leaders through the pages of general national magazines and diversified commercial publications. It stimulates the use of Long Distance in all branches of business—benefiting both Bell and connecting companies.

An Advertisement of the American Telephone and Telegraph Company

THE TECHNICAL CLEARING HOUSE

B. C. BURDEN, Editor



Non-Ring Through Condensers

Q.—What is the correct capacity condenser to use in a magneto telephone to prevent listening subscribers on party lines interfering with line signalling, and where is this condenser placed?

A.—The condensers usually used are either .5 or .8 M. F. A .5 M. F. condenser has an alternating current reactance of 15,900 ohms at 20 cycles and an .8 M. F. condenser has a reactance of 10,000 ohms at 20 cycles. At 1,000 cycles

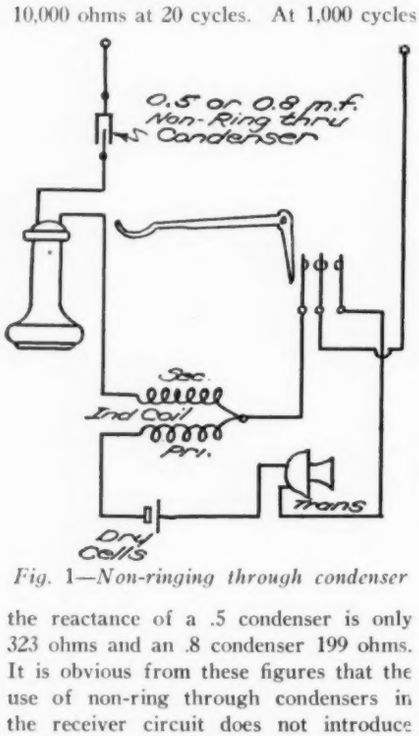


Fig. 1—Non-ringing through condenser

the reactance of a .5 condenser is only 323 ohms and an .8 condenser 199 ohms. It is obvious from these figures that the use of non-ring through condensers in the receiver circuit does not introduce material transmission losses. Fig. *1* shows the location of non-ring through condensers in the subset circuit.

Anti-Side Tone Connections

Q.—Of what advantage is the anti-side tone connection provided on some telephones?

A.—Common battery telephones which are located in exceptionally noisy locations can use a tone reduction circuit to advantage as this makes the transmitter less sensitive to room noises and enables the subscriber at such a location to hear the talking subscriber with less impairment due to the local noise.

Constant Frequency Transmission Tests

Q.—What single frequency is usually used in transmission testing in order to simulate the average voice frequency?

A.—1,000 cycles is now regarded as representing the average voice frequency and most transmission testing utilizes this frequency. It is customary to express transmission equivalents of circuits and apparatus in terms of their 1,000-cycle losses. That is, when it is stated that No. 12 (.109) iron wire has a loss of .30 db. per mile, this means the loss at 1,000 cycles.

24-Gauge Cable

Q.—Is 24-gauge cable considered satisfactory by the larger companies for use in the small exchange plant where the longest cable is one mile or less from the central office?

A.—24-gauge cable has been practically standardized by larger companies for general exchange cable plant, and no difficulty from a transmission standpoint should be encountered where 24-gauge cable carries local circuits and where the cable is not over one mile from the central office. It is generally possible to use longer lengths than one mile without exceeding the allowable transmission limit. However, a special study should be made where this is the case to insure that transmission will be satisfactory for the circuits carried.

ATTENTION, READERS—
This is your Department; use it. Let us answer your questions. Merely write Technical Clearing House, % Telephone Engineer, 192 North Clark St., Chicago, Ill.

Telephone Transpositions

Q.—Is it essential that transpositions in telephone circuits all be thrown in the same direction?

A.—From the standpoint of crosstalk or inductive interference reduction it makes no difference whether the transpositions are thrown right over left, or left over right, or whether they alternate. However, it is standard practice to throw telephone transpositions left over right and for the sake of uniformity this practice should be followed.

Condensers in Parallel and in Series

Q. What is the total capacity of two 1 m. f. condensers in series? In paralle!?

A.—The total capacity of condensers in series is equal to the following formula where C = total capacity and C_1, C_2, C_3, etc., equal individual capacities

$$C = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \text{ etc.}}$$

Two 1 m. f. condensers in series would, therefore, be

$$C = \frac{1}{\frac{1}{1} + \frac{1}{1}} = \frac{1}{2} = 0.5 \text{ m. f.}$$

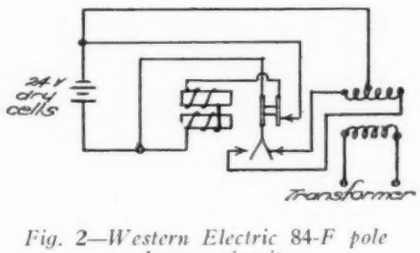


Fig. 2—Western Electric 84-F pole changer circuit

The total capacity of condensers in parallel is equal to the sum of their separate capacities, i.e.,

$$C = C_1 + C_2 + C_3$$

Two 1 m. f. condensers in parallel would be

$$C = 1 + 1 = 2 \text{ m. f.}$$

Voice Frequency Measurements

Q.—How can the magnitude of currents and voltages in telephone circuits due to voice frequency currents be measured?

A.—Voice frequency currents and voltages, because of the relatively high average frequency (1,000 cycles) and the small values involved, cannot be measured by ordinary A. C. meters. They can be measured, however, with vacuum tube voltmeters, thermo-couple, or oxide rectifier type meters. These instruments rectify the A. C. current or voltage and then measure its magnitude on sensitive D. C. meters.

Pole Line Construction

Q.—What height poles are considered good design where the ultimate number of wires will not exceed one arm, and where tree or ground clearances are not the determining factors?

A.—Sixteen-foot poles are being used to a large extent for one-crossarm loads or less.

Vibrating Pole Changer

Q.—Please give the schematic wiring of the Western Electric 84-F pole changer.

A.—See Fig. *2*.

(*Turn to page* 40.)

FORTY YEARS OF KNOWING HOW

THIS company has been in the business of manufacturing wires and cables of every kind and for every purpose, for over forty years. Established in 1889, our sole purpose from that time to this has been to produce none but the highest grades of wire from the finest materials.

When you purchase your wire supplies from us, you are dealing with an organization of specialists, who are thoroughly acquainted with every phase of their business. Our line embraces every type of wire and cable used in Telephone, Telegraph and Power work, and our large stocks enable us to handle "immediate delivery" orders with complete satisfaction. Write for prices.

We are manufacturers of—

Bare and Insulated Copper Wires—Rubber Insulated Wires—Enameled Wire—Magnet Wire—Power Cables—Switchboard Cables—Paper Insulated Cables—Flexible Cords—Electrolytic Copper Rods.

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ESTABLISHED 1889
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FACTORIES
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UNIT OF ASSOCIATED TELEPHONE AND TELEGRAPH COMPANY

SAFE!

Your lines can ride through the storm . . .

Provide your lines with a margin of safety to ride through any sleet or wind storm. Specify National Lumber and Creosoting Company Poles . . . the poles that stay strong, through years of service. Southern Yellow Pine for Strength, Pressure Creosoted for Permanence. That's why they cost less per unit per year.

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GENERAL OFFICES: TEXARKANA, ARK.-TEX

SALES OFFICES
Texarkana, Ark. Houston, Tex.
Kansas City, Missouri
St. Louis, Mo. Denver, Colo. Superior, Wis.

TREATING PLANTS
Texarkana, Tex. Houston, Tex. Alexandria, La.
Pitney (P. O. Col. Park, O) Kansas City, Mo.
Toledo, Colo. Denver, Colo. Superior, Wis.

Inductive Interference on Party Lines

Q.—We have considerable noise on several four-party lines which parallel a high voltage line for a mile. This noise is almost completely reduced when we disconnect all of the ringers from ground. Explain why this is so, also how we may eliminate the noise and sitll retain our four-party service.

A.—A telephone line involved in a parallel with a power line usually has some voltage induced between each wire and ground, even though the power and telephone lines are properly transposed. The transpositions in the telephone line will tend to keep this voltage balanced on the two-line wires, hence it will not be effective in setting up noise currents. If one or both of the telephone wires be grounded either through equipment or by virtue of tree leakage, or dirty lightning arrestors, then the induced power voltage standing on each telephone wire will cause circulating noise currents to flow to ground. Where it is necessary to ground the line wires through the connection of party line ringers, excessive noise currents, on lines involved in severe parallels, may be avoided by using high impedance ringers if they can be obtained, or by means of the plan shown in the following figure, which consists in connecting a dummy balancing ringer at each party line station. Assuming ringers having identical characteristics are used, and the line wires are free from bad splices, this method will be found very effective.

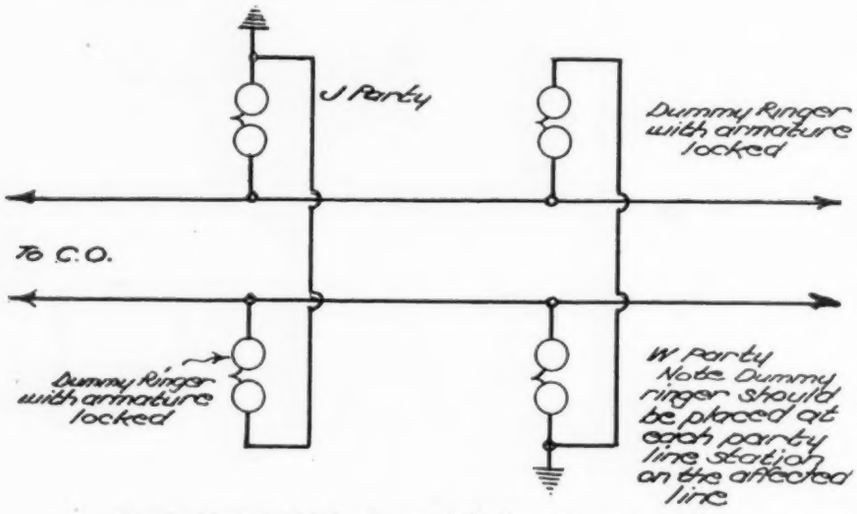
J Party
Dummy Ringer with armature locked
To C.O.
Dummy Ringer with armature locked
W party
Note Dummy ringer should be placed at each party line station on the affected line

Fig. 3—Method of balancing out inductive noise on party lines

Book Review

Relays in Automatic Telephony, their construction, design and adjustment, together with the theory of impulsing and the measurement of time lags, by R. W. Palmer, A. M. I. E. E., Assistant Engineer, G. P. O., London. 192 pages with appendix and illustrations. $3.00.

Here is a volume of untold value to the man who must work with automatic telephones. The author obviously has made a detailed scrutiny and study of telephone relays.

This subject is all-important to the successful operation of automatic telephones, and here he explains simply and clearly, with the assistance of numerous charts and illustrations, how relays are constructed to meet the many diverse requirements in telephone practice, not forgetting the very difficult problem of impulsing.

The general principles of relay construction, and the various mediums of relays; mechanical adjustments of relays; the different speeds of relays, and the causes and effects of this variation in speed; relay design; time measuring instruments and how to use them accurately and beneficially; these are just a few of the intricate problems of which the author of this volume writes enlighteningly.

Transmission Networks and Wave Filters, by T. E. Shea, B. S., M. S., member of technical staff, Bell Telephone Laboratories. Illustrated; 488 pages with index; 6½x9¼; $5.50.

The calculation and design of telephone networks and wave filters are fully presented in this book, based upon the practical experience and extensive research of the Bell Telephone Laboratories.

Explanation of the necessary mathematical and electrical theory proceeds the detailed treatment of the actual equipment. The external performance of networks, balanced and unbalanced networks, and the general characteristics and formulae for the various types of networks and network arms are fully discussed.

Among other subjects covered are included wave filter characteristics and properties, analysis of recurrent signals by the Fourier series, and application of Fourier integral analysis to the solution of purely transient waves.

SHIP-TO-SHORE TELEPHONE SERVICE SPREADS

Ship-to-shore telephone service, considered a most unusual feat only a short time ago, is now being installed for the benefit of water craft almost everywhere.

Permission to erect a radio station to be used for radio-telephone communication between craft plying in New York Harbor and vicinity, and the land telephones of the Bell System, is sought in an application which has been filed with the Federal Radio Commission, through the Supervisor of Radio at the United States Department of Commerce in New York, by the New York Telephone company.

While the harbor radio station is planed primarily to furnish two-way telephone service between tugs, pilot boats, and smaller craft, with telephones on land, it will also be used as an auxiliary to the American Telephone and Telegraph company's ship-to-shore radio-telephone stations at Ocean Gate and Forked River, N. J., providing the permit is granted.

The application asks permission to erect a shore station of 400 watts power, to be located in or near New York City. The station will be connected to a toll or local central office of the New York Telephone company, so that calls to persons on the harbor craft may be made from any telephone in the system.

Out on the Pacific Coast, the Pacific Telephone and Telegraph company is making arrangements to furnish regular telephone service with ships in or near Pacific Coast harbors. Telephone service to ships further at sea will be handled over the Transpacific Communications company's equipment.

The service planned by the Pacific Telephone and Telegraph company will be operated by radio and land lines will become an integral part of its telephone system.

The longest telephone conversation yet recorded between ship and shore was carried on recently between the Belgenland, located between Shanghai and Hongkong, and London, a distance of more than 7,000 miles.

The new common battery switchboard, manufactured by the Stromberg-Carlson Manufacturing company, is now in place in the exchange at Washington, Mo. The power plant and rack is ready for wiring. The date for the cut over has not been decided upon, according to officials

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Blake Insulated Staples

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Unequalled for telephone and bell wiring. The fiber insulation prevents troublesome short circuits and grounds. 4 sizes. Pat. Nov., 1900. Write for samples.

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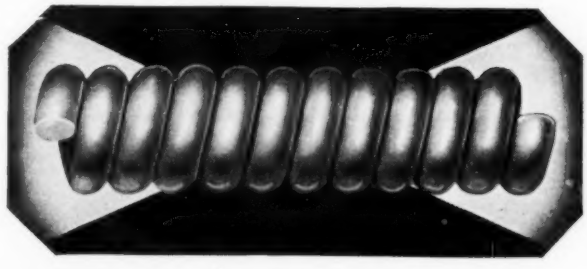

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Look for the **Crapo** Seal!

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The small telephone company, as well as the large, wants to give its customers the very highest type of service. And from coast to coast they're learning that Kester is a valuable ally in this improvement campaign. Many a Plant Supervisor says that Kester does more to keep grief and trouble out of an exchange than any other one thing. Kester's *fast*, too. Carries its flux inside itself—needs only heat—and lessens soldering time by a full third! Start using Kester now—Acid-Core for splices, drops and grounds, Rosin-Core for delicate wiring. Telephone supply houses everywhere sell Kester, on 1, 5 and 20 pound spools. Kester Solder Company, 4218 Wrightwood Avenue, Chicago, Illinois. Incorporated 1899.

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SOLDER

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The "Ne Plus Ultra" in Telephone Exchanges

Strowger Dial Exchange of the Red Hook Telephone Company at Staatsburg, N. Y., Is Latest Word in Artistic Accomplishment. Thousands of People Have Visited This Exchange Since Its Completion.

By J. H. STRATTON
Sales Engineer, Automatic Electric Inc.

Those people of artistic temperament who deplore the modern tendency toward straight, harsh mechanical lines and utilitarian purpose in the design and construction of present-day business buildings, should pay a visit to the new Staatsburg exchange of the Red Hook Telephone company, of Rhinebeck, New York. Here is a telephone building, in the design and furnishing of which the artist and interior decorator have been allowed full sway—and the result is interesting indeed. So interesting, in fact, that this exchange is considered as the show place of the locality, and already thousands of visitors have passed through its doors to see how beautiful and harmonious a modern exchange building can be made to look.

The Dial Exchange building at Staatsburg, N. Y., closely resembles a residence, and is in accord with the beautiful homes of the surrounding area.

But, to start at the beginning of our story—the Staatsburg exchange is one of three owned and operated by the Red Hook Telephone company, of which John Troy is manager. The other two exchanges are at Rhinebeck and Red Hook, the former being the headquarters of the company. Staatsburg is the center of a wealthy residential area located some sixteen miles north of Poughkeepsie—sometimes referred to as the "millionaire colony." Suffice it to say, the district is one of large estates and handsome residences, and no trouble or expense is spared by those living in this vicinity to enhance the attractive appearance of their homes and surroundings. So when a new telephone exchange was being planned by the telephone company, it was agreed that beauty of appearance and attractiveness should be made paramount, as well as the best possible telephone service.

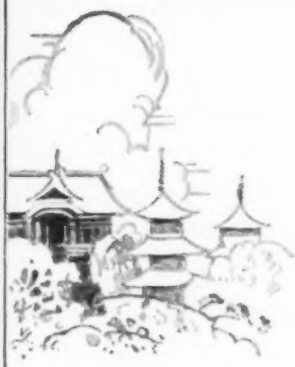
The resulting exchange, now completed and in operation for some time, is unusual in the extreme. Far from appearing as a telephone building, the structure more nearly resembles a home of Dutch colonial type. It is set well back from the street, and a curved flagstone walk leads to the door through tastefully arranged shrubs and a well-kept lawn. The stones used in the erection of the building were hand-picked from some of the old stone fences surrounding the Denmore, Astor and Mills estates. French type windows with shutters, vari-colored shingles for the roof with white trim for the doors and window frames, carry out the general atmosphere of a modern home. The only sign or indication that the building is a telephone exchange are the words "Red Hook Telephone Company," engraved in small characters on the brass door knocker.

The interior decorations are complete to the most minute detail, and no expense has been spared to carry out the illusion of a home-like interior. The windows are fitted with lace curtains and draperies; the walls are covered with a woodland design paper, and the floors are furnished with a linoleum giving the appearance of a flagstone floor. The building is heated by a thermostatically controlled unit, entirely automatic in operation, which, however, may also be controlled manually if desired. A desk of antique design and several comfortable chairs to match are provided. On the desk is a lamp which is automatically lighted every night at sundown by means of a time switch, and turned off at 11 o'clock p. m., to give the passerby the illusion that the building is occupied.

Since this exchange has been in operation it has been a mecca for sightseers, and has aroused a great deal of favorable comment. Mr. Peter H. Troy, of Poughkeepsie, New York, has been instrumental in making the exchange the show place of the vicinity. A key to the building is in the hands of a caretaker who is available at all times to show the building and equipment to anyone passing through the community.

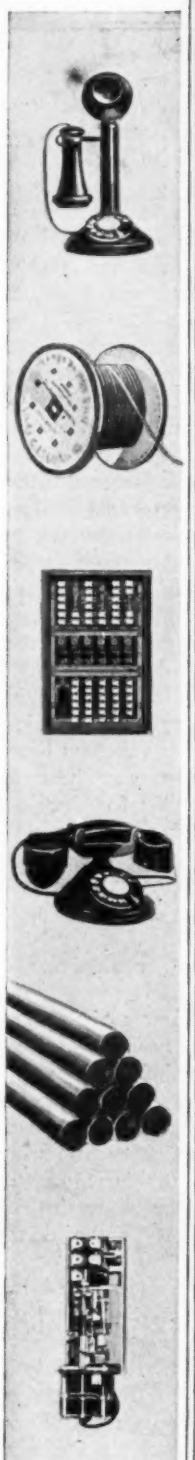
The exchange equipment consists of 75 lines of Strowger dial apparatus, with full automatic features of operation. The neat and efficient apparatus and functioning of this modern equipment has been equally attractive to visitors as a source of interest. While the building proper and its unusual furnishings were provided with a purely artistic idea in mind, it is interesting to note that the use of Strowger dial equipment has greatly stimulated the commercial development of telephone service in the vicinity. So much has the excellent day and night service increased the demand for telephone service hereabouts, that the telephone company finds the original 75 lines of dial equipment which they had thought would be sufficient for the community for years to come, is already overloaded, and plans are being made to enlarge the capacity of the exchange to 200 lines in the near future.

The interior of the Staatsburg exchange, showing the woodland design wallpaper and homelike window drapes.



Tokyo, Japan.

The Marunouchi Dial Exchange Building in Tokyo, equipment for which was manufactured by Automatic Electric Inc. Strowger Automatic Dial Equipment, as made in the Strowger Factories at Chicago and Liverpool, is used throughout Tokyo, as well as other large cities in Japan.



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THE Automatic Electric Company, Limited, has for many years played an important part in supplying telephone companies the world over with products notable for their unimpeachable quality. The high standing of these products is such that no detailed description of them is necessary.

With these products are combined the resources of an experienced staff of sales engineers located at strategic points throughout the world. These representatives are highly expert in telephone matters, and are in constant touch with the latest developments of the foremost research laboratories—which enables them to supply pertinent information and dependable advice to telephone administrations wishing to apply the latest methods and most up-to-date equipment to their telephone networks. Proposals and estimates gladly submitted without obligation for all telephone requirements, either private or governmental, upon request.

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PRIVATE SYSTEMS · CABLES · POLES · BATTERIES · SUPPLIES

Unique Telephone System of Credit Bureau

Credit Rating Corporation of Rochester, New York, Installs Special Stromberg-Carlson Equipment Including Ten-Position Turret Type Table Which Officials of Concern Declare Provides Faster, More Efficient and More Accurate Service for Clients.

By E. A. REINKE

Commercial Sales Manager, Stromberg-Carlson Telephone Manufacturing Company

Many businesses have become wholly dependent on the art of telephony for successfully carrying out their diversified transactions. Among these businesses one stands out prominently—the retail credit bureaus.

Supplying thousands of merchants with credit reports on scores of customers and would-be customers naturally calls for a quick and efficient method of communication, and the managements of credit bureaus have looked to the telephone industry to produce a system of communication which will give the fastest service possible.

One of the most unique systems designed for this type of work has been installed in the offices of the Credit Rating Corporation at Rochester, New York.

This company is one of the oldest and best in the country and serves 700 merchants in Rochester, Monroe county and surrounding counties and is associated with 1,100 other credit bureaus through the National Retail Credit Association.

It has 544,662 complete credit records of individuals, firms and corporations. These reports refer to the character, history, resources, trade opinions and public records of the individual or company.

The company has recently installed the latest type of telephone equipment designed for such use. The system was designed and manufactured by the Stromberg-Carlson Telephone Manufacturing company and was installed by the Rochester (N. Y.) Telephone corporation.

Previous to the installation of the up-to-date equipment the credit corporation's clients were served by means of twelve central office trunks, six on-premise stations, twenty off-premise stations, one PBX switchboard, one four-position and one six-position order table.

Six of these trunks were connected to the larger order table from which oral reports were given out. Written reports were prepared at the smaller order table to which four trunks were connected. The remaining two trunks and all stations appeared only on the PBX switchboard, and attendants at an order table could reach a station only through the operator at the switchboard. Several tie lines were provided between these three points so that the attendants could reach a station.

The management of the corporation was not satisfied with this system because the necessity of using three separate and distinct pieces of apparatus made the system bulky. Also the necessity of completing all stations calls through the PBX switchboard caused a loss of time in handling such calls and introduced a possibility for error. The equipment permitted the use of a maximum of six operators for oral and

Stromberg-Carlson switchboards installed in Credit Rating Corporation offices at Rochester, N. Y.

for written report work, but it did not give a sufficiently flexible method for the proper handling of traffic peaks.

Realizing that with increasing business a more efficient system would be necessary, C. A. Paul, president, and H. T. Haidt, vice-president and bureau manager, conferred with officials of the Rochester Telephone corporation regarding new equipment. The telephone officials immediately consulted Stromberg-Carlson officials, and engineers of both companies designed a system which Mr. Paul and Mr. Haidt declare is the best they have ever seen in operation.

The new equipment consists of a special ten-position turret type order table in which is incorporated a master position which serves as a switchboard for the members of the organization, other than reporters, who are provided with desk telephones. This arrangement makes a compact unit. The ultimate capacity of the board is 30 trunks and 60 direct lines. All stations and all trunks appear before every attendant and each one has direct access to all trunks and stations.

The minimum average of outgoing calls per month is 20,000 and the minimum average of incoming calls per month is 12,000 calls. There are 15 trunks and 28 direct lines now in use. These averages hold true for both the old and new equipment, but the calls are handled much faster by the new equipment. According to Messrs. Paul and Haidt, with the new equipment each operator can handle 100 reports a day, while the maximum with the old equipment was 60.

About one-half of the calls for reports are completed within three or four minutes when holding a subscriber on the line. The balance of the reports are called back to the subscriber after the necessary checking of references has been made by telephone. This accounts for the larger number of outgoing calls. The average time to call back and complete report has been reduced to between 10 and 15 minutes, depending upon the number of references to be checked.

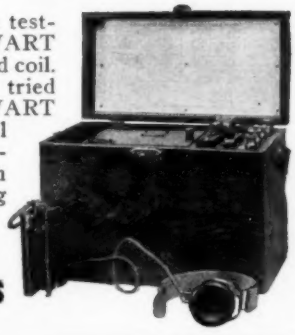
Both Mr. Paul and Mr. Haidt highly praise the new Stromberg-Carlson equipment and state that it has exceeded their expectations in performance. The new set-up has made it possible for them to give their clients faster and more efficient service.

Summing up the advantages and improvements of the new system the two officials state that:

1. An operator is not required for a PBX board.
2. There is a great degree of flexibility, eliminating the confusion of transferring calls from a switchboard to the other by the lines.
3. Operators may be changed from verbal to written report work and vice versa without changing positions.
4. Every line is at the finger tips of all operators with not even the delay of handling cords.
5. A smaller space is demanded by the new equipment, permitting the best possible arrangement of filing cabinets.
6. The production of the operators has been increased due to the efficiency of the new equipment and the better arrangement of equipment and filing cabinets.
7. Three less employees are required to handle an increased volume of work.
8. Voice noise has been greatly reduced.
9. There is room for several years of expansion.

"STEWART" Cable Tester

Trade in your old cable tester, any make, on a STEWART Cable Tester with balanced coil. One user says: "I have tried them all, and the STEWART is the only one that will always locate water trouble." Price, complete with receiver and exploring coil, $57.00.



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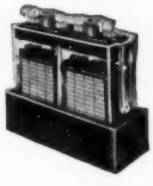
OTTAWA, ILLINOIS



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The Jewell Pattern 89 Ohmmeter provides a simple means for quickly and accurately checking or making resistance measurements on all outside lines and central office circuits.

It is completely self-contained, very light in weight, and is easily carried in a pocket. A standard 1½ volt flashlight cell within the case provides the necessary potential. Accurate measurements are assured by a simple screw adjustment that compensates completely for any change in battery voltage.

The Jewell Pattern 89 Ohmmeter is available in single and double range models, with ranges expressly designed for telephone testing.

Write for detailed information concerning this useful instrument.

Pattern 89 Ohmmeter Single Range

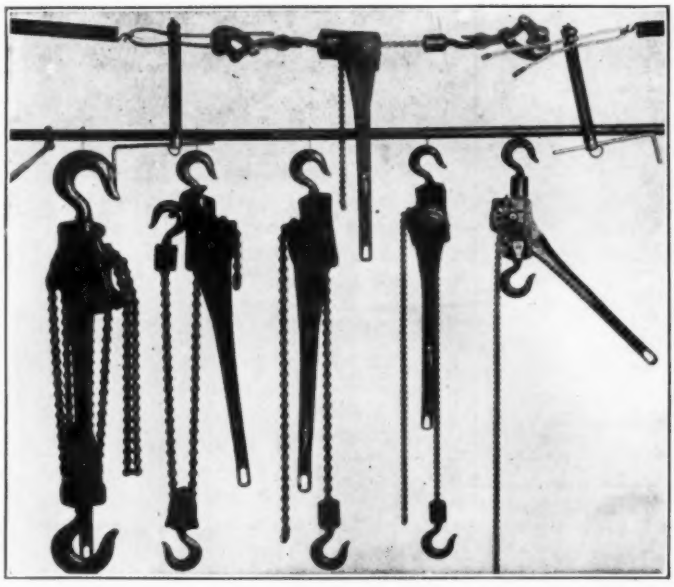
Full Size Scale, Single Range Ohmmeter

Jewell Electrical Instrument Company
1650 Walnut Street, Chicago, Illinois

Coffing Hoist and Guy Clamp

The Lineman's Friends

FAMILY GROUP



Model Z 6 Ton Weight 65 lbs.	Model F. S. 3 Ton Weight 36 lbs.	Model F. 1½ Ton Weight 25 lbs.	Model A. ¾ Ton Weight 13 lbs.	Model A Reversed

Hoists can be used either end up or in any position.
A truly one-man tool, light, fast, powerful, simple, durable.
Models A and F particularly adapted to utility work, pulling guys, messenger wires, underground cables, poles, lifting transformers, loading heavy supplies, booming poles. Also have a pole jack for pulling and straightening poles. Pole clamp for changing top cross arms on corners and in pole lines. Will send on 30 days' trial.

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BAIT AND FLY CASTING TOURNAMENTS
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EXHIBITION HALL
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9TH ANNUAL CONVENTION
Izaak Walton League
(Conserving America's Natural Resources)
WILL BE HELD AT SAME TIME

LINE AND DESK

HELPFUL HINTS FROM HERE AND THERE

CABLE TENTS

One useful appliance seldom considered by telephone companies is the aerial cable splicers tent. Everyone knows that to work on aerial cable when it is windy, rainy or cold is most difficult unless suitable protection is available. The usual method of protection followed is to wire up a tarpaulin in a makeshift manner, sometimes with the aid of boards nailed together a "T" shape and tied to the messenger. At best this is only a half-way shelter which generally blows away when it is most needed.

There is on the market a special cable splicers tent including a metal framework which clamps rigidly to the messenger. This can be placed properly with very little effort and will stay placed even in a bad storm. Special openings are provided at each end for the cable to come through and the tent may be tied down and left to cover an unfinished splice over night or for as long as required. It is much safer and easier to leave an uncompleted splice in a suitable tent than to wrap it up in any manner which will be storm proof. With the tent arrangement it is not necessary to lose a good half hour in the morning unwrapping a splice before starting to work. When an unfinished splice is wrapped it is a common occurrence to get the tag strips tangled up in such a manner that it is a real job to get them straightened out. A tent over a splicer will also safeguard a splice against damage from a sudden shower in the summertime.

An exchange with any amount of aerial cable in service should have at least two of these regular cable splicers tents available at all times to safeguard their cable operations. They will find that they are real labor, time and money savers and a sound investment for the most careful, cautious telephone companies.

DO YOU KNOW YOUR SPECIFICATIONS?

Last month's problems, appearing on page 30 of the March issue, were not difficult, as you will see by comparing your answers with the following.

No. 1—Service Drops.

Service drops shall have a vertical clearance of 18 feet over the traveled portion of thoroughfares. This may be reduced to 16 feet at the curb line.

Service wires supported on clearance arms shall have a clearance of 40 inches under supply circuits, and point of attachment to arm shall be 15 inches from center line of pole.

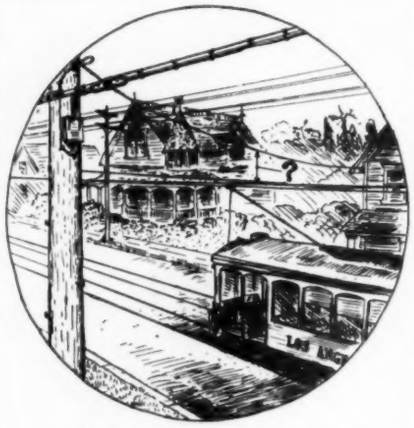
This 40-inch separation may be reduced to two feet if required to secure ground clearance providing supply voltage does not exceed 750 and service wires are supported at a horizontal distance of 25 inches from the center line of pole.

No. 2—Vertical Risers.

Moulding is required on vertical cable risers where the cable is within an 8-foot vertical distance from trolley or supply conductors supported on the same pole, or where within a 6-foot horizontal distance of trolley or supply conductors supported by another pole. A riser terminating in aerial cable or terminal shall be covered with moulding from such aerial cable or terminal to a point 8 feet below supply circuit. Risers shall also be protected above ground for a distance of 8 feet to prevent mechanical injury.

DO YOU KNOW YOUR SPECIFICATIONS?

Have you encountered cases similar to the above? What instructions would you give your men? Watch for the answers next month.



TROLLEY CONTACT WIRES

Are crossings permitted? If so, what is required clearance? Know your specifications.

(Editor's Note.—These problems are published through courtesy of the California Independent Telephone Association, and answers are provided according to California Railroad Commission orders. There is sometimes a slight variation in telephone rulings of different states, due to differences in population, highways, topography, and climate. Therefore the answers to these problems as published here may not coincide exactly wtih the answer which would be correct in your state. However, any variation will be slight. The California rulings were chosen as most generally applicable.)

RAILROAD CROSSINGS

How long a span between the poles? When is suspension strand needed? What clearance over tracks? What kind of attachment at each end?

OPERATOR'S EQUIPMENT REQUIRES ATTENTION.

An exchange is judged for efficiency by its neighboring plants according to how well they hear the operator and to keep the operator's transmitter and transmitter battery up in good condition goes a long way toward securing high regard for the service by local subscribers.

An operator's transmitter, being in service almost constantly, should not be expected to last for a long period of years without attention. An extra operator's transmitter should be kept on hand at all times so as to give opportunity for cleaning and overhauling the regular transmitter without interruption to service.

Care must be used when using high resistance transmitters not to turn the transmitter over on its back, as the carbon is very fine and will often become so loose that the transmitter will not talk well until one or two words have been spoken into it loudly to make the carbon settle back to its proper working condition.

Operators' receivers should be inspected and rusted-out diaphragms replaced with new. Diaphragms should be kept as close as possible above the magnets without "freezing," and where a large air gap is found, the ear cap and diaphragm should be removed and the receiver given a few strokes on a flat sandpaper surface to reduce the air gap to the correct dimensions.

(*Continued on page* 48.)

TELERING

The Super-Ringing Machine

Designed not only for Central Office use, but is ideal for Private Branch Exchanges.

Reduces cable congestion.
Removes ringing leads from cables.
Improves P. B. X. service

Low First Cost.
Negligible Operating Expense
No Radio Interference.

Operated by Commercial Alternating Current.

FULLY GUARANTEED!

Price $44.00 F. O. B. Elyria

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(Write for booklet)

LOW COST POWER for magneto boards

Fansteel Combination Power Unit, Type CAB-4, operates from A.C. light socket, supplying dependable D.C. power for 1, 2 and 3 position boards. Consumes only a few watts. Storage battery reserve will operate boards for days in case of A.C. line failure. Ask your regular supply house or write for bulletin and prices.

Fansteel Products Company, Inc.
NORTH CHICAGO, ILL.

We Carry Complete Stocks of

• TELEPHONES, TELEPHONE APPARATUS CONSTRUCTION MATERIALS AND SUPPLIES

OUR unusual facilities as manufacturers and distributors of telephones, telephone apparatus and manual and automatic switchboard equipment enable us to render unexcelled service in Western Canada.

Independent Sales and Engineering Company, Limited

VANCOUVER, B. C.

Representatives in Canada for

AMERICAN ELECTRIC CO., INC., Chicago
AUTOMATIC ELECTRIC INC., Chicago
AUTOMATIC TELEPHONE MANUFACTURING CO., LTD., Liverpool
THE AUTOMATIC ELECTRIC COMPANY, LIMITED, Chicago
UNIT OF ASSOCIATED TELEPHONE AND TELEGRAPH COMPANY

Termite Attack of Untreated Crossarms

Wood Rot Is Not the Only Enemy of Telephone Poles and Crossarms According to C. M. Tilley, Superintendent, Texas Creosoting Company, Who Tells in This Article How These Dangers May Be Overcome

The practice of using untreated crossarms on pole lines has been extensively followed by a number of utility engineers for many years, and in some cases even where the builders of the lines are convinced of the economy and desirability of treated poles they still continue the use of the untreated crossarm. Usually a rot-resisting species of wood is selected; the theory being that the crossarm, not having a ground line area, should last as long as the treated pole supporting it. Where rot alone is the only factor to reckon with, it is possible that there may be some virtue to this theory, but if the termite is to be considered, and we all have to consider them, this supposition seems to go sadly askew.

Fig. 1—Termite attack on untreated arm showing damage whole length of arm.

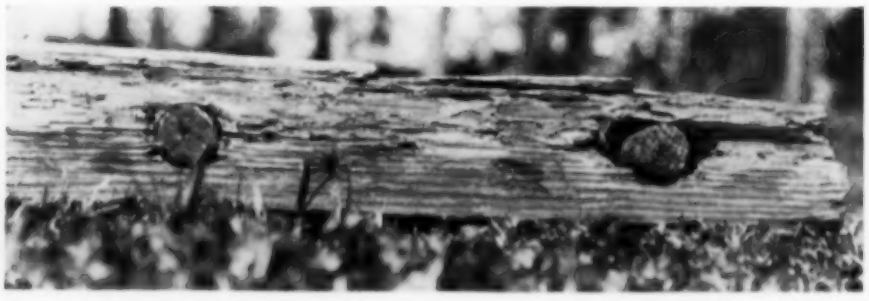
The termites seem to have very little difficulty in reaching the top of a pole and have been known to go even higher. Once the attack is launched it is only a question of a very short time before the untreated crossarm is rendered unfit and fails.

The usual attack of the termite seems to be more pronounced around the pin. Possibly this is because the pin hole is a readily available point of entrance, even with the pin itself in place. This causes the enlargement of the hole so that the pin readily pulls out even when the arm is not damaged enough to be replaced. One instance is known in which the attack was so bad that all the arms in a section of line had to be replaced after ten years of service. Approximately thirty-five per cent of these replacements were made on creosoted pine poles which had replaced the untreated poles which had failed during that period. It is perhaps unnecessary to add that the replacements were made with treated crossarms.

Fig. 4—Showing termite attack on butt treated pole attack seems as bad in butt treated area as in the untreated portion above.

This section of line was also a very good example of the poor results obtained from superficial treatment, as all the poles were given a butt treatment to a point well above the ground line. This did not seem to have any appreciable effect in retarding the termite attack, as they attacked this treated area as readily, through the checks which developed, as they did the untreated wood.

Fig. 3—Showing damage to interior of arm. Sometimes there is very little evidence of this condition on outside of arm.



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(*Continued from page* 46.)

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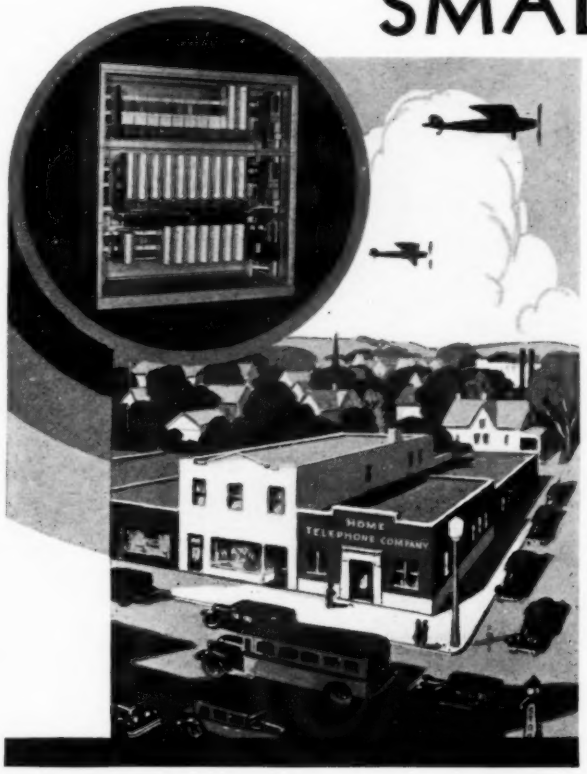
An economy can be effected by using two sets of dry cells and connecting them to a double pole throw switch and marking one side even and the other odd. The switch should be thrown to the even and odd on the corresponding days of the month.

SMALL COMMUNITIES Want Modern Service, Too!



STANDARDS of living *are* changing! Even the most cursory survey of the smaller communities and farming districts shows that people living in such areas are demanding—and getting—modern mail delivery, radio programs, transportation facilities—in fact, the best that can be had. They want, and will pay for, the most up-to-date services that are available—and telephone service is no exception.

To get the new business which they should get—to merit public confidence and good will—even to continue to exist, profitably—telephone companies operating small exchanges and rural lines *must*, eventually, meet this demand for modern, twenty-four hour service. Strowger Dial equipment, in types specially developed for small communities, offers the most practical and profitable solution yet devised.

With the new sectional (Type 51) units, standard, time-proven Strowger switches are so mounted on sectional frames, that practically any available floor space can be utilized, and expansion is easily accomplished by merely adding sections, as growth requires. For further details, write for Bulletin 1551. Engineered, manufactured and installed by Automatic Electric Inc., Chicago. U. S. A.

Automatic Electric Inc.

Manufacturers of

STROWGER AUTOMATIC DIAL TELEPHONE AND SIGNALING SYSTEMS

Factory and General Offices: 1033 West Van Buren Street, Chicago, U. S. A.

Sales and Service Offices in All Principal Cities

UNIT OF ASSOCIATED TELEPHONE AND TELEGRAPH COMPANY

STROWGER AUTOMATIC DIAL SYSTEMS

GENERAL EXPORT DISTRIBUTOR
The Automatic Electric Company, Ltd., Chicago

In Canada · Independent Sales and Engineering Co., Ltd., Vancouver
In Australasia · Automatic Telephones Ltd., Sydney
In Japan · Automatic Telephones Ltd. of Japan, Tokyo
In China · Automatic Telephones of China Federal Inc., U. S. A.
In South Africa · Automatic Telephones (So. Africa) Ltd., Johannesburg

ASSOCIATED COMPANIES
American Electric Company, Inc., Chicago
International Automatic Telephone Co., Ltd., London
Automatic Telephone Manufacturing Co., Ltd., Liverpool
The New Antwerp Telephone and Electrical Works, Antwerp
Eugene F. Phillips Electrical Works Ltd., Montreal

PBX switchboard, one four-position and one six-position order table.

Six of these trunks were connected to the larger order table from which oral reports were given out. Written reports were prepared at the smaller order table to which four trunks were connected. The remaining two trunks and all stations appeared only on the PBX switchboard and attendants at the order tables could reach a station only through the operator at the switchboard. Several tie lines were provided between these three points so that the attendants could reach a station.

ever seen in operation.

The new equipment consists of a special ten-position turret type order table in which is incorporated a master position which serves as a switchboard for the members of the organization, other than reporters, who are provided with desk telephones. This arrangement makes a compact unit. The ultimate capacity [illegible] lines. All stations and all trunks appear before every attendant and each one has direct access to all trunks and stations.

The minimum average of outgoing calls per month is 20,000 and the mini-

of handling cords.

5. A smaller space is demanded by the new equipment, permitting the best possible arrangement of filing cabinets.

6. The production of the operators has been increased due to the efficiency of the new equipment and the better arrangement of equipment and filing cabinets.

7. The [illegible] to handle an increased volume of work.

8. Voice noise has been greatly reduced.

9. There is room for several years of expansion.

Model Z
6 Ton
Weight
65 lbs
Hoists can
A truly one
828, messenger
ers, loading hea
for pulling and
cross arms on cor
COFFI
317 East Vanb

Model Z 6 Ton Weight 65 lbs.	Model F. S. 3 Ton Weight 36 lbs.	Model F. 1½ Ton Weight 25 lbs.	Model A. ¾ Ton Weight 13 lbs.	Model A Reversed

Hoists can be used either end up or in any position.
A truly one man [illegible] particularly adapted to utility work, pulling cable, messenger wires, underground cables, poles, lifting transformers, loading heavy supplies, booming poles. Also have a pole jack for pulling and straightening poles. Pole clamp for changing top cross arms on corners and in pole lines. Will send on 30 days' trial.

COFFING HOIST COMPANY
317 East Vanbren Street DANVILLE, ILLINOIS

LINE AND DESK

HELPFUL HINTS FROM HERE AND THERE

CABLE TENTS

One useful appliance seldom considered by telephone companies is the aerial cable splicers tent. Everyone knows that to work on aerial cable when it is windy, rainy or cold is most difficult unless suitable protection is available. The usual method of protection followed is to wire up a tarpaulin in a makeshift manner, sometimes with the aid of boards nailed together a "T" shape and tied to the messenger. At best this is only a half-way shelter which generally blows away when it is most needed.

There is on the market a special cable splicers tent including a metal framework which clamps rigidly to the messenger. This can be placed properly with very little effort and will stay placed even in a bad storm. Special openings are provided at each end for the cable to come through and the tent may be tied down and left to cover an unfinished splice over night or for as long as required. It is much safer and easier to leave an uncompleted splice in a suitable tent than to wrap it up in any manner which will be storm proof. With the tent arrangement it is not necessary to lose a good half hour in the morning unwrapping a splice before starting to work. When an unfinished splice is wrapped it is a common occurrence to get the tag strips tangled up in such a manner that it is a real job to get them straightened out. A tent over a splicer will also safeguard a splice against damage from a sudden shower in the summertime.

An exchange with any amount of aerial cable in service should have at least two of these regular cable splicers tents available at all times to safeguard their cable operations. They will find that they are real labor, time and money savers and a sound investment for the most careful, cautious telephone companies.

DO YOU KNOW YOUR SPECIFICATIONS?

Last month's problems, appearing on page 30 of the March issue, were not difficult, as you will see by comparing your answers with the following.

No. 1—Service Drops.

Service drops shall have a vertical clearance of 18 feet over the traveled portion of thoroughfares. This may be reduced to 16 feet at the curb line.

Service wires supported on clearance arms shall have a clearance of 40 inches under supply circuits, and point of attachment to arm shall be 15 inches from center line of pole.

This 40-inch separation may be reduced to two feet if required to secure ground clearance providing supply voltage does not exceed 750 and service wires are supported at a horizontal distance of 25 inches from the center line of pole.

No. 2—Vertical Risers.

Moulding is required on vertical cable risers where the cable is within an 8-foot vertical distance from trolley or supply conductors supported on the same pole, or where within a 6-foot horizontal distance of trolley or supply conductors supported by another pole. A riser terminating in aerial cable or terminal shall be covered with moulding from such aerial cable or terminal to a point 8 feet below supply circuit. Risers shall also be protected above ground for a distance of 8 feet to prevent mechanical injury.

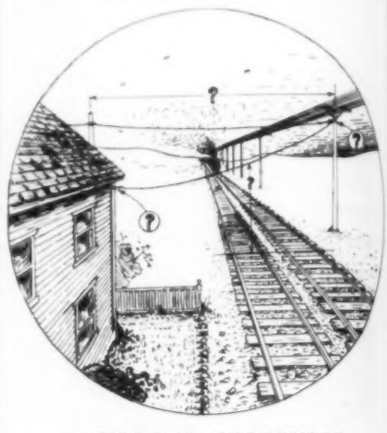
DO YOU KNOW YOUR SPECIFICATIONS?

Have you encountered cases similar to the above? What instructions would you give your men? Watch for the answers next month.

TROLLEY CONTACT WIRES

Are crossings permitted? If so, what is required clearance? Know your specifications.

(Editor's Note.—These problems are published through courtesy of the California Independent Telephone Association, and answers are provided according to California Railroad Commission orders. There is sometimes a slight variation in telephone rulings of different states, due to differences in population, highways, topography, and climate. Therefore the answers to these problems as published here may not coincide exactly wtih the answer which would be correct in your state. However, any variation will be slight. The California rulings were chosen as most generally applicable.)



RAILROAD CROSSINGS

How long a span between the poles? When is suspension strand needed? What clearance over tracks? What kind of attachment at each end?

OPERATOR'S EQUIPMENT REQUIRES ATTENTION.

An exchange is judged for efficiency by its neighboring plants according to how well they hear the operator and to keep the operator's transmitter and transmitter battery up in good condition goes a long way toward securing high regard for the service by local subscribers.

An operator's transmitter, being in service almost constantly, should not be expected to last for a long period of years without attention. An extra operator's transmitter should be kept on hand at all times so as to give opportunity for cleaning and overhauling the regular transmitter without interruption to service.

Care must be used when using high resistance transmitters not to turn the transmitter over on its back, as the carbon is very fine and will often become so loose that the transmitter will not talk well until one or two words have been spoken into it loudly to make the carbon settle back to its proper working condition.

Operators' receivers should be inspected and rusted-out diaphragms replaced with new. Diaphragms should be kept as close as possible above the magnets without "freezing," and where a large air gap is found, the ear cap and diaphragm should be removed and the receiver given a few strokes on a flat sandpaper surface to reduce the air gap to the correct dimensions.

(*Continued on page* 48.)

TELERING

The Super-Ringing Machine

Designed not only for Central Office use, but is ideal for Private Branch Exchanges.

Reduces cable congestion.
Removes ringing leads from cables.
Improves P. B. X. service

Low First Cost.
Negligible Operating Expense
No Radio Interference.

Operated by Commercial Alternating Current.

FULLY GUARANTEED!

Price $44.00 F. O. B. Elyria
It pays for itself.

Sold by Leading Telephone Distributors.

TELKOR, INC., ELYRIA, OHIO
(Write for booklet)

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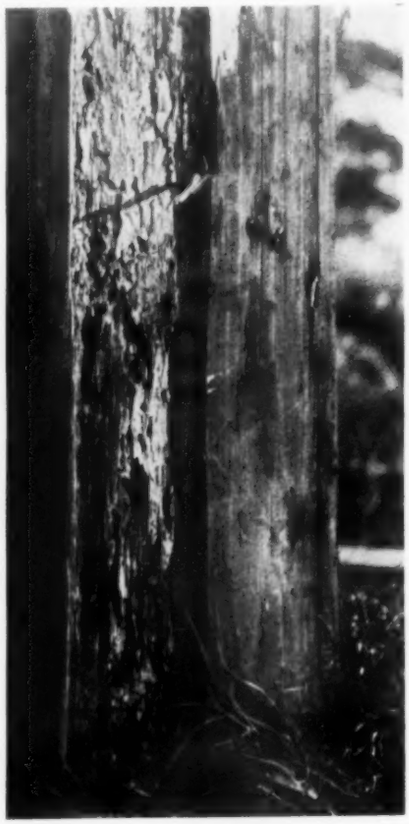

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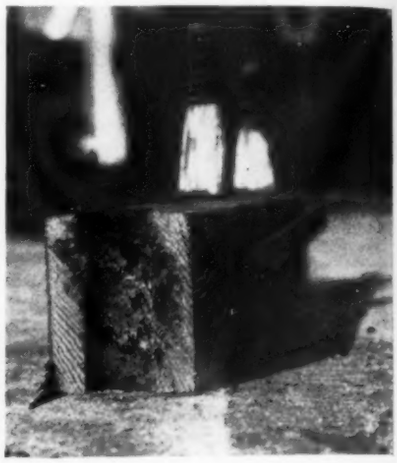

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Eugene F. Phillips Electrical Works Ltd., Montreal

With Manufacturers and Jobbers

IMPROVED BOLT AND WIRE CUTTER JOINS VACUUM GRIP FAMILY

A new bolt and wire cutter, characterized by extreme simplicity of design and unusual cutting power, is announced by the makers of the well known Vacuum Grip Pliers. Built on the compound lever principle, it multiplies hand power to an unusual degree, and will be found to be particularly useful for cutting bolts

New bolt and wire cutter recently placed on the market by the Forged Steel Products Company

and wire on high line construction work.

The new tool, known as lineman's Special No. 114, fills the long-felt want for a light weight cutter that can be hung from the lineman's belt, along with his pliers and other tools. Although only 14" in length it takes care of bolts up to 5/16" and wire of corresponding gauges, a cutting capacity equal to that of the ordinary 18" bolt cutters.

The cutting blades are hammer-forged from finest electric furnace high carbon special alloy tool steel, hardened and tempered through and through, giving them a cutting capacity far in excess of ordinary steel. The extreme toughness of this steel permits the use of keenly edged cutting blades, which make for the maximum in cutting ease. The handles, made of hammer-forged alloy tool steel, are capable of standing extreme pressures that would break handles of malleable cast steel.

The new cutter is assembled from only three major parts—the two sections making up the handles and the interchangeable cutting blade unit. There are no bolts and nuts to cause trouble and loss of time during replacement, as a new set of blades can be quickly substituted for the old blade unit by the removal of two setscrews. Specially heat-treated blades are furnished for hardened wire, also end-cut type of blades. Full details and prices will be furnished on application to the Forged Steel Products Co., Newport, Pa.

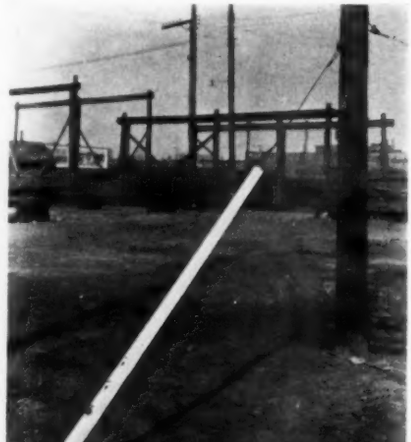
DAIREN, MANCHURIA, TO HAVE MORE AUTOMATIC TELEPHONES

The Automatic Electric company, Ltd., of Chicago, Illinois, announces that it has received orders from the Kwantung Direction General of Communications, Dairen, Manchuria, for 600 lines of additional Strowger dial equipment for that city. This addition will be made to the Sakako office which is already under Strowger dial operation, as is most of the city of Dairen. Rotary type line-switches will be furnished, and the equipment will be manufactured by Automatic Electric, Inc., of Chicago.

The order received by the Automatic Electric Company, Ltd., also includes considerable additional dial trunking equipment destined for use in main office at Dairen. This equipment will be manufactured by the Automatic Telephone Manufacturing company, Ltd., of Liverpool, England. The growth of Dairen as an industrial and trading center, as well as the increasing popularity of the dial telephone due to the speedy and accurate service it renders, combine to necessitate continued expansion of the city's telephone system by the telephone administration.

NEW GUY GUARD INTRODUCED BY W. N. MATTHEWS

The W. N. Matthews corporation, manufacturers of electrical specialties, announces the new Matthews guy guard



New Matthews guy guard

which embodies many advantages not obtainable on any other type of guy guard now on the market.

The new Matthews guy guard is made of hot dip galvanized No. 14 Birmingham gauge steel. It is composed of a single piece, and is easily and quickly installed in about one minute. Oval holes permit placing either head or nut of clamp bolt on top surface of guard. The Matthews guy wire may be installed from the ground on any guy without the aid of ladder, as the only attachment to make secure is the one guy clamp bolt near the ground. Rigidly bolted to the guy clamp, the guard cannot twist or turn over with variation in tension of strand, and has high visibility.

This new guy guard rigidly and automatically clamps strand at upper end of guard. It will go on any size of strand from 5/16 to ½ inch. There are four places where this guard may be attached to the guy clamp bolts. This provides that necessary flexibility for taking care of anchor rods that may protude as much as 30 inches from the ground. It will not slip up or down on the guy if hit by a vehicle. The Matthews guy guard only touches the guy wire at one point.

The new Matthews guy guards are so designed that they will nest 80 per cent—one within another. This puts them in the third rate freight classification which saves from 14 to 24 per cent all over the U. S. A. and more to foreign countries by water routes.

WOOD PRESERVING CORP. HAS NEW ADVERTISING MAN

The Wood Preserving corporation of Pittsburgh announce the appointment of Reding Putman as advertising manager. Mr. Putman comes to the Wood Preserving corporation with a broad background of experience in the lumber industry. After graduation from Northwestern University in Chicago, he spent several years in the logging camps, sawmills and retail yards of the Edward Hines Lumber company. Then followed several years of advertising and trade promotion effort with the Southern Pine Association, and for the past year he has been engaged in advertising work for one of William Randolph Hearst's metropolitan newspapers. Mr. Putman expects to make his home in Pittsburgh.

The Wood Preserving corporation, with headquarters in Pittsburgh, is a name comparatively new in the industry. It is composed, however, of companies whose names are among the oldest in the field of wood preservation. The various companies that together make up the Wood Preserving corporation are the Ayer & Lord Tie company, the National Lumber and Creosoting company and the Century group. With twenty-two treating plants located in twenty different states east of the Rockies, timber stands in the South Atlantic, Southern and Western regions and sales offices in the principal cities throughout the territory, the Wood Preserving corporation is now the largest as well as the most widely located organization in the industry. All of the plants are equipped for pressure treatment using all of the standard methods for impregnating wood, and while creosote and zinc chloride are the chief preservatives used, facilities are had for treating with zinc meta-arsenite, Montan wax and Wolman salts.

Super-Service on rush orders!

If you are in a hurry your order can be loaded and on the way the same day we receive it. Quality poles since 1882 assures you of guaranteed stock and satisfactory dealings. Let us quote you prices.

Northern and Western Cedar
With or without butt treatment

NAUGLE POLE & TIE COMPANY
59 East Madison Street, Chicago
Branches: New York, Columbus, Kansas City, Spokane, Los Angeles, Boston, Madison.
Main Yards and Butt-treatment Plants: Minneapolis, Pinconning, Michigan, Spokane, Sand Point, Idaho, Seattle, Arrowhead, B. C.

Naugle Poles

Insure Your Overhead Lines

BY SPECIFYING

MacGillis

NORTHERN or WESTERN

CEDAR POLES

PLAIN or BUTT-TREATED
FROM
120 E. Wisconsin Avenue

The MacGillis & Gibbs Co.
MILWAUKEE - WISCONSIN

Carney

Producers of
"CARNEYPOLES"
of
WESTERN RED CEDAR
Plain or Treated
B. J. CARNEY & CO.
100 No. Seventh St. Minneapolis, Minn.

Cedar Poles

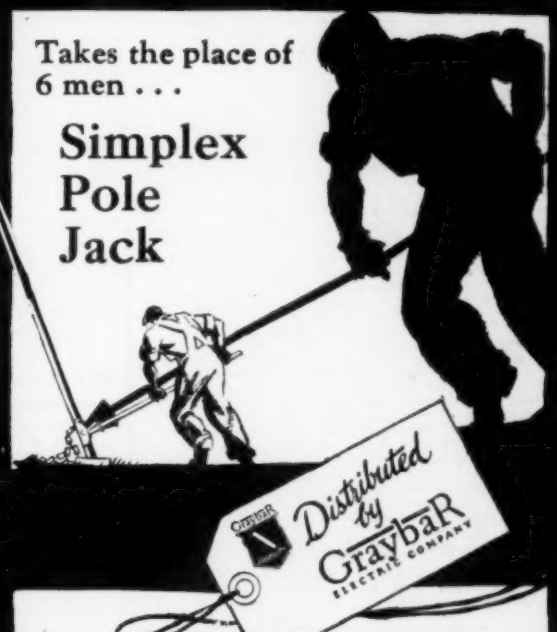
Northern White Western Red
Plain or Treated Butts

Prompt Shipment from Minneapolis Yard.

T. M. Partridge Lumber Co.
Minneapolis, Minn.

Takes the place of 6 men . . .

Simplex Pole Jack



Templeton, Kenly & Co., Ltd.
Sole Manufacturers
Established 1899 Chicago, Ill., U. S. A.
Foreign Distributors:
International Standard Electric Corporation
Northern Electric Company, Ltd.

STROMBERG-CARLSON SUBMITS ANNUAL REPORT

The annual report of the Stromberg-Carlson Telephone Manufacturing company, Rochester, N. Y., for 1930 shows net earnings of $669,703.20, equal, after paying $65,000 of dividends on its 10,000 preferred shares, to $2.21 a share on its 273,280 common shares. This compares with a net of $1,070,055.58 or $3.74 a share earned in 1929.

Besides the 6½ per cent dividend on its preferred shares, the company paid $1.00 regular and $.37½ extra, or $372,014.02, on its common shares, and had remaining a net addition to surplus for the year of $234,371.44. This addition to surplus increases the book value of the common shares $.85 a share, to a total book value of $24.57 a share.

The company's dividend on its common shares has increased from $1.00 regular and $.12½ extra in 1927 and 1928, to $1.00 regular and $.25 extra in 1929 and to $1.00 regular and $.37½ extra in 1930.

Current assets, as of December 31, 1930, amount to $5,823,339.88 as against current liabilities of $1,415,184.06, a ratio of 4.1 to 1.

The company entered radio actively about seven years ago. While its telephone sales during that seven-year period have averaged the largest in its history, its radio sales have gradually grown to the point where they have more than doubled the company's opportunity for volume and profit. Of 1930's volume, 60 per cent was radio business and 40 per cent telephone business.

The company has been unusually successful in providing continuous employment for its workers.

Stromberg-Carlson was one of the fourteen companies in Rochester which adopted last month an unemployment benefit plan which, commencing in 1933, assures 60 per cent of wages during future periods of unemployment to employees earning less than $50 a week, for periods ranging from four weeks for employees with service of six months up to thirteen weeks for employees of service of five years or more.

HIAWATHA, KANSAS, TO GET STROMBERG BOARD

The American Telephone Company has purchased eight sections of the No. 3 Stromberg-Carlson Switchboard, for its Hiawatha, Kansas, exchange, it was recently announced by the Stromberg-Carlson Telephone Mfg. Company.

The board, the capacity of which will be 1,600 lines, will be equipped with 1,010 Central Energy and 90 Toll and Rural lines and will be complete with terminal, power and machine equipment.

FOR SALE—Kellogg late type magneto switchboard, capacity 150 lines, equipped 60 lines, refinished. Price $180.00. Corwin Electric Co., Indianapolis, Indiana.

MISSOURI TELEPHONE MAN INJURED

P. K. Higgins, general manager of the Scotia Telephone Company, St. Louis, Mo., is recovering from injuries sustained four months ago when he fell downstairs. As a result of the accident the nerves below the knee and in his foot were shattered.

RECONSTRUCTED EQUIPMENT

Kellogg No. 2696 type 4-bar 1000 or 1600 ohm Bdg. compacts @	$ 8.50
Western Elec. No. 317 inside connection 3-bar 1000-1600 or 2500 ohm Bdg. compacts @ $8.75—4-bar with S. C. Gen. @ $9.25—5-bar @	10.00
Dean Elec. No. 240 type 4-bar 1000 or 1600 ohm compacts with Kellogg transmitters @	7.00
Stromberg Carlson No. 104 type 4-bar 1000-1600 or 2500 ohm Bdg. compacts @ $6.90—5-bar @	9.25
Chicago Tel. 4-bar 1000 or 1600 ohm Bdg. compacts @	6.75
Am. Elec. No. 36 4-bar 1000-1600 or 2500 ohm Bdg. compacts @ $6.50—5-bar with Kellogg Transmitters @	8.25
Kellogg (Cast head) desk set with W. E. No. 240 external post connection signal set 3-bar 1000-1600 or 2500 ohm @	8.00
Kellogg (Cast head) desk set with S. C. 4-bar 1000-1600 or 2500 ohm inside cord connection signal set @	8.75
Kellogg No. 97 or No. 118 C. B. desk set with unbreakable head complete with Straight line No. 259 or No. 75 Steel bell boxes @	7.00
Western Elec. No. 293 C. B. Straight line Black finish wood hotel sets with No. 20 Ind. Coil, W. E. Trans. & Rec. @	6.50
Kellogg No. 79 C. B. Ind. Coils @	.40
Western Elec. No. 240 External post connection 3-bar 1000-1600 or 2500 ohm Bdg. hotel sets with W. E. Trans. & Rec. @	5.00

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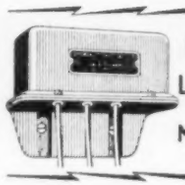
Chicago, Ill.



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Lamp Jacks, single mounting @ 10c.
24 or 48 volt Switchboard Lamps @ 11c.
No. 264 Four-Party Ringing Keys @ $2.09
We have some odd lots of pole hardware and Cable terminals. Also Telephone Booths with folding doors. Prices and description on request.
Telephone Repair Shop
1760 Lunt Ave., Chicago, Ill.

Western Electric Co.
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Line-Cutoff Relays

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1000 lines (per line) 60
2500 lines (per line) 50
A-1 and A-2 line and cutoff relays on No. 737-A mounting (per line and cutoff relay) 1.00

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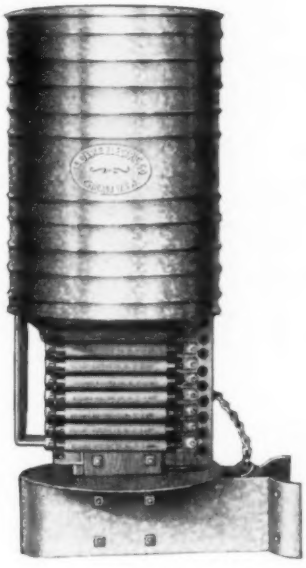

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